JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY
(Established by H.P. State Legislative vide Act No. 14 of 2002)
Waknaghat, P.O. Dumehar Bani, Kandaghat, Distt. Solan – 173234 (H.P.) INDIA
Website :www.juit.ac.in
Phone No. (91) 01792-257999 (30 Lines)
Fax : (91) 01792 245362

Criteria	2 Teaching-learning and Evaluation
Key Indicator	2.6 Student Performance and Learning Outcomes
Metric	2.6.1 The institution has stated learning outcomes (generic and programme specific) / graduate attributes which are integrated into assessment process and widely publicized through the website and other documents

COs of All Courses – Department Biotechnology and Bioinformatics

(BTech- BI)

Semester: I

SNo	Course Codes	Course Name	Course Outcomes
1.	18B11BT111	Fundamental Biology	CO1 Overview of living system, differentlife forms and Maintenance of Life. CO2 Fundamental understanding of Bio-molecules: Building blocks of living system CO3 Understanding of structure and function of cell: Prokaryotic and Eukaryotic cellssystem. CO4 Understanding the Basic of cellular transport system and cellular inheritance.CO5 Flow of information in biological system-Central Dogma, DNA replication, Transcription, and Translation
2	18B17BT171	Fundamental Biology lab	CO1 Introduction to basic laboratory practices, microscopy,Bio- safety cabinet and sterilization. CO2 Fundamental understanding of Biological buffers preparation and application. CO3 Introduction to microscopic examination of different biological system. CO4 Introduction to analytical techniqueand application in macromolecular estimation. CO5 Able to understand ethics, teamwork and discipline.

Semester - III

SNo	Course Codes	Course Name	Course Outcomes
	18B11BI311	Cell and Molecular Biology	CO1 Able to describe the chemical components of the macromolecules of life and their functions and the structural differences between prokaryotic and eukaryotic cells or between plant and animal cells. CO2 Understand how molecular machines within the cell are constructed and regulated so that they can accurately copy, repair, and interpret genomic information. CO3 Write, discuss or critique about emerging biology-related topics individually or in groups.

	20B11BI311	Bioinformatics Data Management	CO1 Explain the characteristics, architecture of database approach, its components, different data models and the examples. CO2 For a given query write relational algebra expressions for that query and optimize the developed expressions. CO3 For a given specification of the requirement, design the databases using E-R method and normalization. CO4 Determine the functional dependency between two or more attributes, compute the closure of a set of attributes, evaluate a proposed decomposition CO5 Give examples of the application of primary, secondary, and clustering indexes, explain the theory and application of internal and external hashing techniques.
	18B11BI312	Microbiology & Immune System	CO1 Usage of scientific terminologies to describe & express fundamental concepts inMicrobiology and Immunology. CO2 Able to apply basic principles to understand host-microbe relationship indifferent Infectious diseases. CO3 Able to connect and integrate the knowledge obtained for applications related to Microbes, their tools and database. CO4 Able to connect and integrate the knowledge obtained for and applications related to Immunology, Vaccines related informatics. CO5 Able to connect and integrate the knowledge of microbiology and immunology from the perspective of a bioinformatician with special emphasis on microbe-immune interface.
	18B11BI313	Biological Computation	CO1 Basic algorithms used in Pairwise and Multiple alignments. CO2 Understanding the methodologies used for database searching, and determining the accuracies of database search. CO3 Application of probabilistic model to determine important patterns. CO4 Prediction of structure from sequence and subsequently testing the accuracy of

			predicted structures. CO5 Determine the protein function from sequence through analyzing data. CO6 Analysis and development of models for better interpretation of biological data to extract knowledge.
	20b17BI371	Bioinformatics Data Management Lab	CO1 Design and implement a database schema CO2 Design different views of tables for different users and to apply embedded and nested queries CO3 Understand the use of structured query language and its syntax , transactions, database recovery and techniques for query optimization CO4 Understand , analyze and apply common SQL statements including DDL , DML , DCL statements to perform different operations CO5 Develop application programs using PL/SQL
	18B17BI371	Cell and Molecular Biology Lab	CO1 Students will learn the basic laboratory practices CO2 Students will learn use and handling microscope CO3 The students will be able demonstrate isolation of single bacterial colony through serial dilution CO4 Students will able to prepare buffer and extraction of genomic DNA from *E.coli*

	18B17BI372	Microbiology & Immune System Lab	CO1 Students will be able to understand and apply basic microbiological techniques and correlate them with their fundamental concepts in the subject. CO2 Students will be able to understand and apply basic immunological techniques and correlate them with their fundamental concepts in the subject. CO3 At the end of the course, students are expected to gain a broad appreciation of the basic methods and their application in the field of microbiology, handle microbial cultures independently, to study applied aspects of microbiology. CO4 At the end of the course, students are expected to gain a broad appreciation of the basic methods and their application in the field of immunology along with applied aspects of immunology.
	18B17BI373	Biological Computation Lab	CO1 Basic algorithms used in Pairwise and Multiple alignments. CO2 Understanding the methodologies used for database searching, and determining the accuracies of database search. CO3 Application of probabilistic model to determine important patterns. Prediction of structure from sequence and subsequently testing the accuracy of predicted structures. CO4 Determine the protein function from sequence through analysis of data. CO5 Analysis and development of models for better interpretation of biological data to extract knowledge.
	18B17BI374	Linux Lab	CO1 To understand Unix environment CO2 Familiarize with Unix and Linux commands. CO3 To learn and master Bash and Shell scripting CO4 To learn automating script-based job scheduling in Unix CO5 To learn and master administrating and managing super user-based managing accounts. CO6 To run command line scripts of Perl and Python

Semester - IV

SNo	Course Codes	Course Name	Course Outcomes
	18B11BI412	Genetic Engineering and Genomics	CO1 Students will become aware of concept ofgenetic engineering and genomics and its applications. CO2 Students will have knowledge of tools and strategies used in genetic engineering. CO3 Student will acquire knowledge about genelibraries and isolation of genes. CO4 Student will develop understanding of DNA and genome sequencing technologies. CO5 Student will be able to explore domains ofgenomic technologies.
2	18B11BI413	Structural Biology	CO1 Understand the relationship between proteinstructure and its function. CO2 Understand the methods of characterizingprotein's structure using X-ray and NMR methods CO3 Implementation of bioinformatics toolsin understanding protein structures. CO4 Understanding the classification ofprotein databases. CO5 Introduction to protein engineering Understand the structural diversity in nucleicacids.

3	18B11BI414	Programming Languages for Bioinformatics	CO1 Write and execute a script in Perl. CO2 Enable routine and module calls and theirimplementation using Bioperl. CO3 Able to formulate stepwise implementation of a Perl script (from developing a pseudo-code to execute a successful bug-free code) for a given problem in Bioinformatics. CO4 Write and execute a script in Python. Enable routine and module calls and theirimplementation using Biopython. CO5 Able to formulate stepwise implementation of a Python script (from developing a pseudo-code toexecute a successful bug-free code) for a given problem in Bioinformatics.
4	18B17BI472	Genetic Engineering and Genomics Lab	CO1 Students will be able to isolate and analyze plasmid vectors. CO2 Students will be cut and ligate DNA fragments/vectors with help of restriction enzymes and ligase. CO3 The students will be able to prepare competent cells CO4 The students will be Students will be able to perform genome annotations, gene and molecular marker prediction
5	18B17BI473	Structural Biology Lab	CO1 Understand the relationship between protein structure and its function. CO2 Understand the methods of characterizing protein's structure using X-ray and NMR methods CO3 Implementation of bioinformatics tools in understanding protein structures. CO4 Understanding the classification of protein databases. Introduction to protein engineering CO5 Understand the structural diversity in nucleic acids.

6	18B17BI474	Programming Languages for Bioinformatics Lab	CO1 Write and execute a script in Perl. CO2 Enable routine and module calls and their implementation using Bioperl. CO3 Able to formulate stepwise implementation of a Perl script (from developing a pseudo-code to execute a successful bug- free code) for a given problem in Bioinformatics CO4 Write and execute a script in Python Enable routine and module calls and their implementation using Biopython. CO5 Able to formulate stepwise implementation of a Python script (from developing a pseudo-code to execute a successful bug- free code) for a given problem in Bioinformatics
7	18B11GE411	Environmental Studies	CO1 Introducing basic concept of environmental studies, interdisciplinary nature and scope of the subject CO2 Understanding ecosystem services and its functioning as well as equitable use of natural resources. CO3 Understanding Pollution, A threat to the environment and finding its solutions, CO4 Pollutant sampling and monitoring of samples. CO5 Correlating the concept of Biodiversity and its importance to human mankind CO6 Understanding social issues and their impact on environment. CO7 Role of Information Technology in environment and human health

Semester: V

SNo	Course Codes	Course Name	Course Outcomes
I	18B11BI511	Design and Analysis of Algorithms	CO1 For a given algorithms analyze worst-case running times of algorithms based on asymptotic analysis and justify the correctness of algorithms. CO2 Describe the greedy paradigm and explain when an algorithmic design situation calls for it. For a given problem develop the greedy algorithms. CO3 Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Synthesize divide-and conquer algorithms. Derive and solve recurrence relation CO4 Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. For a given problems of dynamic programming and develop the dynamic programming algorithms, and analyze it to determine its computational complexity CO5 For a given model engineering problem model it using graph and write the corresponding algorithm to solve the problems. Explain the ways to analyze randomized algorithms (expected running time, probability of error) CO6 Explain what an approximation algorithm is. Compute the approximation factor of an approximation algorithm (PTAS and FPTAS).

2	18B11BT511	Bioprocess Engineering	CO1 Able to use correct biological terms to describe & analyze phenomena/problems in bioprocesses CO2 Able to apply engineering principles to address issues in various bioprocesses Able to analyze bacterial growth kinetics (homogeneous reaction) in batch /continuous/ Fed-batch reactor and sterilization CO3 Able to understand and to solve problems related to bioprocess phenomena including mixing, Mass transfer and sterilization CO4 To develop a strong foundation about bioreactor designs and their applications CO5 Able to understand the basis of bioprocess scale up and the related basic design calculations
3	18B11BI512	Scripting Languages for Bioinformatics	CO1 Able to apply design principles to develop web based applications specially for biological data analysis CO2 To understand working on world wide web through implementations CO3 Use various methods from computational biology to implement their programmatic versions CO4 Able to design new web pages and web sites CO5 Able to developed programs to describe and analyze problems in biology
4	18B17BI571	Design and Analysis of Algorithms Lab	CO1 Student will understand the running time using time library functions. Learn to prepare table for input size vs. running time. Learn to measure best run and worst run of the experiments CO2 Students will learn to implement various types of design for algorithms and compare the approaches. CO3 Students will learn to implement network algorithms and their applications. CO4 Student will learn to implement classical NP problems CO5 Students will learn to implement approximate algorithms for real world problems. CO6 Students will learn to implement randomized solution for difficult real

				world problems.
5	18B17BT571	Bioprocess Engineering Lab	CO1 CO2 CO3 CO4 CO5 CO6	Able to apply practical knowledge to understand the various important process engineering aspects involved in biotechnology industries Able to design experiments and analyze various data related to various practices in bioprocess engineering Ability to apply theoretical concepts for data analysis and interpretation and their documentation Able to run fermenter and also to analyze their results Able to understand and determine various growth kinetics parameters in a batch culture Able to work in a team to accomplish the experiments and to document the experiments properlyin lab note books
6	18B17BI572	Scripting Languages for Bioinformatics Lab	CO1 CO2 CO3 CO4 CO5	To understand working on world wide web through implementations for client and server side programming Able to developed programs to describe and analyze problems in biology. Able to design new web pages and web sites. To understand coordination of HTML, Java Script and PHP. Able to develop web based applications especially for biological data analysis.

7	18B17BI573	Structural Bioinformatics Lab	CO1 CO2 CO3 CO4 CO5 CO6 CO7 CO8 CO9 CO10 CO11	Understanding the fundamental concepts of structural biology (chemical building blocks, structure, superstructure, folding, etc.) To Understand and use structural databases and software for structure visualization To understand the algorithms used in Structure determination and quality assessment To perform protein structure comparison and the hierarchical nature of biomacromolecular structure classification To understand the methodology of protein structure prediction and assessment To understand the methodology of sequence- and structure-based functional site prediction
8	18B1WBI531	**Departmental Elective-I** Structural Bioinformatics	CO1 CO2 CO3 CO4 CO5 CO6 CO7	Understanding the fundamental concepts of structural biology (chemical building blocks, structure, superstructure, folding, etc.) To Understand and use structural databases and software for structure visualization To understand the algorithms used in Structure determination and quality assessment To perform protein structure comparison and the hierarchical nature of Bio macro molecular structure classification To understand the methodology of protein structure prediction and assessment To understand the methodology of sequence- and structure-based functional site Prediction

9	18B1WBT532	Comparative & Functional Genomics	CO1	Students will have a thorough understanding of various genomic technologies such as whole genome mapping & sequencing, genome annotation, global gene cloning and gene expression technologies, comparative genomics, introduction to pharmacogenomics
			CO2	The students will know the vast amount of genome information in publically available databases andhow to access and best utilize forpractical purposes.
			CO3	Able to analyze the gene expression data sets to derive the biologically meaning information
			CO4	Able to apply the knowledge of function genomics in public health

Semester: VI

SNo	Course Codes	Course Name	Course Outcomes	
1	18B11BI611	Machine Learning for Bioinformatics	CO1	Different types of machine learning and its utility in bioinformatics
			CO2	Application of Hidden Markov Model and Artificial neural networks to different types of bioinformatics data
			CO3	Determination of Bayesian Network (BN) from expression data.
			CO4	Application of symbolic machine learning (SML) methods to predict cleavage site of HIV- protease from training data of positive and negative cases.
			CO5	Optimization of weights in a supervised and unsupervised neural network, and application of supervised learning to predict sub- cellular localization of a protein.
			CO6	Application of stochastic context-free grammar (SCFG) to predict RNA secondary structure.

2	18B11BI612	Computer Aided Drug Design	CO1 CO2 CO3 CO4 CO5 CO6	Feasibility study of a drug development project Design and optimize lead molecules against drug target, and using ligand-based approach Determination of pharmacophore from lead molecules and active sites and use of pharmacophore for lead discovery Development of potential drug molecule and pharmacophore databases for virtual screening Use of molecular fragments for lead discovery and implementation of statistical approaches for lead molecule discovery Bioavailability prediction of a drug and working capability in drug designing software like, Discovery Studio and molecular dynamics software like AMBER 8.0, On-line tools, etc.
3	18B17BI671	Machine Learning for Bioinformatics lab	CO1 CO2 CO3 CO4 CO5 CO6	Implementation of KNN using Perl/Python Implementation of ANN using Perl/Python Application of Hidden Markov Model for CpG island prediction Application of HMMER package and Pfam database Application of Transformational Grammars in bioinformatics Application of SVM in bioinformatics

4	18B17BI672	Computer Aided Drug Design Lab	CO1 CO2 CO3 CO4 CO5 CO6 CO7	Feasibility study of a drug development project Design and optimize lead molecules against drug target, and using ligand-based approach Determination of pharmacophore from lead molecules and active sites and use of pharmacophore for lead discovery Development of potential drug molecule and pharmacophore databases for Virtual screening Use of molecular fragments for lead Bioavailability prediction of a drug and working capability in drug designing software like, Discovery Studio and molecular dynamics software like AMBER 8.0, On-line tools, etc.
	18B17BI673	Advanced Algorithms for Bioinformatics Lab	CO1 CO2 CO3 CO4 CO5 CO6	Able to understand algorithmic principles To write programs for specific computational biology problems Analyze problems in biology and able to design new protocols and algorithms for biological data analysis Able to analyze biological data through programs Implement algorithms for bioinformatics problems and their assessments
5	18B17BI674	R Language Lab	CO1 CO2 CO3 CO4 CO5	Able to apply various approaches in R Software and tools to understand concept of Statistics Use various programming techniques in R to implement algorithmic methods from computational biology to describe and analyze problems in biology Implement various packages of R for their application in bioinformatics To apply R with universal features through available packages
		Departmental Elective-II		

6	18B1WBI631	Advanced Algorithms for Bioinformatics	CO1 CO2 CO3 CO4 CO5	Able to apply algorithmic principles to address problems in biology Use various methods from computational biology to implement their algorithmic versions Analyze problems in biology and able to design new protocols and algorithms for biological data analysis Able to analyze the algorithms in computational biology and identify their limiting factors to propose new design principles Assessment of biological complexity through algorithmic principles
7	18B1WBT632	Infectious Diseases	CO1 CO2 CO3 CO4 CO5	The students would have knowledge of infectious diseases for practical use in medicine and biotechnology. The students would have in-depth knowledge of basic concepts related to infectiousdiseases, immunology and epidemiology. The students would develop knowledge and understanding of the basic form, function, behavior,and diversity of infectious agents and their interaction with the host. The students would develop knowledge and skill about important techniques The students would have sound knowledge of mode of action and resistance towards the agents used to treat infectious diseases.
1	18B1WBI632	**Departmental Elective-III**		

		Dataware housing and Mining for Bioinformatics	CO1 CO2 CO3 CO4	Students will have a thorough understanding of various data warehousing components and architecture. Students will understand various types of data models. Students will understand how to perform feature selection and derive association rules Students will understand how to perform various types of data mining, including clustering, neural networks etc.
2	18B1WBT634	Bioenergy & Biofuels	CO1 CO2 CO3 CO4 CO5	Advantages and disadvantages of Bioenergy and Biofuels over fossil fuels Technical barriers in Bioenergy and Biofuel Technology Whole biorefinery approaches for economical implementation into the market Conversion technologies of waste to Biofuels, Bioproducts, and Bioenergy Conversion of waste and Mixed feedstock to Biofuels, Bioenergy andBioproducts

Semester: VII

SNo	Course Codes	Course Name	Course Outcomes	
		Departmental Elective-IV		
1	18B1WBI731	Computational Systems Biology	CO1	Able to understand the holistic approaches of systems biology combining acquisition, integration and management of experimental data with computer modeling and simulation
			CO2	Use various methods from computational systems biology to learn the engineering aspects of controlling biological systems through reverse engineering
			CO3	Able to analyze biological systems and identify their limiting factors to propose new design principles for the biological systems
			CO4	Computational analysis of biological networks and their applications towards the function and evolution of networks
			CO5	Usage of recent technologies to solve system level problems for biological networks and pathways
2	18B1WBT734	Intellectual Property Rights & Commercialization	CO1	To enable students with basic concepts and knowledge of intellectual property rights.
			CO2	To apply and execute different types of IP protection in research and academics.
			CO3	Able to understand about the mechanisms of different IP protections, registrations and applications
			CO4	
			CO5	To be capable of tackling issues related to IP and its commercialization
			CO6	Able to learn the strategies for effective IP management and commercialization
			CO7	To apply the knowledge of IPR for the benefit generation and for mass utilization

Semester: VIII

SNo	Course Codes	Course Name	Course Outcomes
		Departmental Elective- V	
1	18B1WBT831	Genetic Counselling	CO1 The students will acquire knowledge of Next Generation Sequencing CO2 technologies used in genomics and genetics research. CO3 The students will learn about the various platforms used in NGS. CO4 The students will learn about the tools and techniques used in NGS data CO5 analysis. CO6 The students will know the applications andscopes of genomics research CO7 using the latest genome-wide data centric approaches.
2	18B1WBI831	Computational Molecular Evolution	CO1 Able to understand the holistic approaches of molecular evolution CO2 Combining acquisition, integration and management of experimental evolutionary data with computer aided analysis CO3 Use various methods from computational genomics and proteomics to learn their functional aspects CO4 Able to analyze various kind of biological sequence data and identify their limiting factors to propose new design principles for the analysis of biological data CO5 Applications of evolutionary analysis through various available approaches

		Departmental Elective- VI	
1	18B1WBT833	Diagnostics & Vaccine Manufacture	CO1 The students would be able to identify and analyze what DNA based approach and CO2 methodology should be used for diagnostic purpose in different settings, their comparative advantages and limitations. CO3 The students would be able to identify and analyze what antigen - antibody based approach and methodology should be used for diagnostic purpose in different settings, their comparative advantagesand limitations. CO4 The students would have in-depth knowledge of various types of vaccines and approaches used for their production. CO5 The students would have in-depth knowledge of quality control and assurance considerations used in the industry for diagnostics. CO6 The students would have in-depth knowledge of antimicrobial susceptibility and its application in the industry for diagnostics.
2	18B1WBI834	NGS Data Analysis & Applications	CO1 The students will acquire knowledge of Next Generation Sequencing CO2 technologies used in genomics and genetics research. CO3 The students will learn about the various platforms used in NGS. CO4 The students will learn about the tools and techniques used in NGS data analysis CO5 The students will know the applications and scopes of genomics research using the latest genome-wide data centric approaches.