Ordinance No. :- V-126-B-37

(Approved in Academic council meeting held on 11.03.2026
Proposed to be ratified in forthcoming executive council)

Evaluation Scheme and Syllabus
of
B.Sc. Bioinformatics
FOUR – YEAR UNDER GRADUATE PROGRAM
(AS PER NEP-2020)

Keral Verma Subharti College of Science

Swami Vivekanand
SUBHARTI UNIVERSITY
Meerut

(Effective from session 2025-26)

K. V. Subharti College of Science
S. V. Subharti University
NH-58 Bypass Road, Meerut

PROGRAM OBJECTIVES

PO1: Build Strong Foundations in Life Sciences and Computational Biology

PO2: Develop Competence in Bioinformatics Tools, Databases, and Algorithms

PO3: Foster Scientific Inquiry, Problem-Solving, and Research Skills

PO4: Promote Digital, Computational, and AI-Based Competencies

PO5: Cultivate Innovation, Entrepreneurship, and Industry Readiness

PO6: Strengthen Ethical Reasoning, Biosafety Awareness & Responsible Research Practice

PO7: Develop Effective Communication, Documentation & Presentation Skills

PO8: Encourage Lifelong Learning and Adaptability to Emerging Technologies

PO9: Integrate Interdisciplinary Knowledge for Real-World Problem Solving

PO10: Foster Holistic, Socially Responsible, and Value-Driven Education

PROGRAM OUTCOME

PSO1: Biological Literacy and Conceptual Understanding

PSO2: Computational and Programming Proficiency

PSO3: Bioinformatics Databases, Tools, and Analytical Skills

PSO4: Scientific Reasoning, Research Aptitude, and Problem-Solving

PSO5: Data Science, Machine Learning, and AI Applications in Life Sciences

PSO6: Laboratory Skills and Experimental Competence

PSO7: Ethical, Legal, and Social Responsibility in Biosciences

PSO8: Effective Communication and Documentation Skills

PSO9: Entrepreneurship, Innovation, and Industry Readiness

PSO10: Multidisciplinary Integration and Holistic Thinking

PSO11: Digital Fluency and Financial/Digital Citizenship

PSO12: Lifelong Learning, Adaptability, and Professional Growth

CREDIT DISTRIBUTION TABLE

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Life Science

B.Sc Bioinformatics
(Session 2025-26 onwards)

		I	II	III	IV	V	VI	VII	VIII	Total
1	Major	6	6	9	15	10	14	16	4	80
2	Minor	3	3	3	3	6	6	4	4	32
3	Multi Disciplinary	3	3	3						9
4	Ability Enhancement Course	2	2	2	2					8
5	Skill Enhancement Course	3	3	3						9
6	Value Added Course	3	3							6
7	Internship					4				4
8	Research								12	12
	Total	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**160**

K. V. Subharti College of Science
S. V. Subharti University
NH-58 Byepass Road, Meerut

EVALUATION SCHEME

YEAR: I

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Biotechnology													
Course Name - B.Sc. Bioinformatics													
Batch:2025-26							SEM:I						
S.No.	Course Type	Course Code	Course Name	Teaching Load			Credits		Internal Assessment		External Assessme	Total	Remark
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 1	BSBI-101	Introduction to Cell Biology and Genetics	4	0	0	4	5	10	15	70	100	
2	Practical 1(Based on Major 1)	BSBI-101P	Cell Biology and Genetics Lab	0	0	4	2	5	10	15	70	100	
3	Minor 1	BSBI-102	Biochemistry	3	0	0	3	5	10	15	70	100	
4	Multi Disciplinary	M-DIS- SM	Soil Microbiology	3	0	0	3	5	10	15	70	100	
5	Ability Enhancement Course	AEC-01	English Communication	2	0	0	2	5	10	15	70	100	
6	Skill Enhancement Course	SEC-AE	Advance Excel	1	0	3	3	5	10	15	70	100	
7	Value Added Course	VAC-AILS	AI for Life Sciences	3	0	0	3	5	10	15	70	100	
8	Qualifying	IKSRB-01	IKS / Rastra bodh	2	0	0	2	5	5	10	30	50	Qualifying
TOTAL CREDITS / ASSESSMENT							20	35	70	105	490	700	

K. V. Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Biotechnology

Course Name - B.Sc. Bioinformatics

Batch:2025 -26 | SEM:II

S.No.	Course Type	Course Code	Course	Teaching Load			Credits	Internal Assessment			External Assessme	Total	Remark
				L	T	P		Attendance (5)	quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
THEORY and PRACTICAL SUBJECTS													
1	Major 2	BSBI-201	Fundamental of Bioinformatics	4	0	0	4	5	10	15	70	100	
2	Practical 2 (Based on Major 2)	BSBI-201P	Fundamental of Bioinformatics Bioinformatics Lab	0	0	4	2	5	10	15	70	100	
3	Minor 2	BSBI-202	Microbiology	3	0	0	3	5	10	15	70	100	
4	Multi Disciplinary 2	M-DIS-		3	0	0	3	5	10	15	70	100	
5	Ability Enhancement Course 2	AEC-02	Environment Science	2	0	0	2	5	10	15	70	100	
6	Skill Enhancement Course 2	SEC-		1	0	3	3	5	10	15	70	100	
7	Value Added Course 2	VAC-DFL	Digital and Financial Literacy	3	0	0	3	5	10	15	70	100	
8	Qualifying	IKSRB-02	IKS / Rastra bodh	2	0	0	2	5	5	10	30	50	Qualifying
TOTAL CREDITS / ASSESSMENT							20	35	70	105	490	700	

K. V. Subharti College of Science
S. V. Subharti University
NH-58 Bypass Road, Meerut

SYLLABUS (SEMESTER: I)

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: I**
Credits: 4 L 4 T 0 P 0	**Subject: Major I**
Course Code: BSBI-101	Title: Introduction to Cell Biology and Genetics

Course Objectives:

CO1: Understand the basic concepts of biotechnology and the structural and functional organization of cells and cellular organelles.

CO2: Explain the structural features of chromosomes and the molecular mechanisms involved in cell division, cell cycle, and its regulation.

CO3: Demonstrate comprehensive knowledge of Mendelian and non-Mendelian patterns of inheritance and genetic interactions.

CO4: Analyze the types, causes, and effects of mutations and understand sex determination mechanisms in plants and animals.

CO5: Evaluate population genetics concepts and inherited genetic disorders, applying them to real-world biological problems.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits:40%

Unit	Content	Lecture
Unit I	Cell as a basic unit of living systems and cellular organelles: Concept, Development and Scope of Biotechnology, Historical perspectives, Discovery of cell, the cell theory, Ultra-structure of a eukaryotic cell (both plant and animal cells), Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, Nucleolus, Nucleoplasm, Chromatin), Vacuole, Cytosol, and Cytoskeleton structures (Microtubules, Microfilaments, Intermediate filaments), Surface architecture: Structural organization and functions of plasma membrane and cell wall of eukaryotes, Ultra-structure of plasma membrane – fluid mosaic model, membrane fluidity, Transport across membranes - Symport, Antiport, Uniport, Active and Passive transport, Differentiation of cell surface: Basement membrane, Tight junction, Gap junctions, Desmosomes, Hemidesmosomes.	**12**
Unit II	Chromosomes and cell division: General Introduction, Discovery, Morphology and structural organization – Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition and Karyotype, Single-stranded and multistranded hypothesis, Folded-fiber and nucleosome models, Genome organization, Cell division: Cell cycle phases, Mitosis and Meiosis, Regulation of cell cycles, Cell cycle checkpoints and enzymes involved in regulation, Significance of cell cycle, Mitosis and Meiosis, Interphase nucleus, Achromatic apparatus, Synaptonemal complex, Cell cycle regulation, Cell senescence, and Programmed cell death.	**12**

Unit III	Genetics: Introduction and brief history of genetics, Mendelian theory: Laws of inheritance – Dominance, Segregation, Incomplete dominance, Codominance with examples, Law of independent assortment, Test cross and Back cross, Deviations from Mendelian inheritance: Complementary, Supplementary, and Interaction of genes (13:3 ratio), Epistasis, Maternal inheritance, Sex-linked inheritance, Chromosome theory of inheritance, Linkage and Crossing over, Gene interaction: Multiple factors (Skin colour in human beings, Epistasis), Multiple allelism (Blood groups in human beings).	**12**
Unit IV	Mutations: Types of mutations – Spontaneous and Induced, Mutagens – Physical and Chemical, Sex determination in plants and animals: Concept of allosomes and autosomes, Non-Mendelian inheritance patterns: Mitochondrial inheritance, Complex inheritance – Genetics and environmental variation, Heritability, Behavioural traits, Analysis of quantitative and qualitative traits.	**12**
Unit V	Population genetics: Phenotype, Genotype, Gene frequency, Hardy-Weinberg Law, Factors disturbing Hardy-Weinberg equilibrium – Mutation, Selection, Migration, Gene flow, Genetic drift, Inherited disorders – Allosomal (Klinefelter syndrome and Turner's syndrome) and Autosomal (Down's syndrome and Cri-Du-Chat Syndrome).	**12**

Text Book &References :

Text:

Gupta, P. K. — Cell and Molecular Biology

Verma, P.S., & Agarwal, V.K. — Cell Biology, Genetics, Molecular Biology, Evolution and Ecology

Singh, B. D. — Genetics

References:

Alberts, B., Johnson, A., Lewis, J., et al. — *Molecular Biology of the Cell* (Garland Science)

Lodish, H., Berk, A., Kaiser, C. A., et al. — *Molecular Cell Biology* (W.H. Freeman)

Pierce, B. A. — *Genetics: A Conceptual Approach* (W. H. Freeman & Co.)

Lewin, B. — *Genes XII* (Jones & Bartlett Learning)

Griffiths, A. J. F., et al. — *An Introduction to Genetic Analysis* (W. H. Freeman)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the structure, functions, and organization of eukaryotic cells, their organelles, and membrane systems, including cell surface specializations.

CLO2: Describe the structure, organization, and types of chromosomes, and explain the mechanisms and significance of cell division, cell cycle, and its regulation.

CLO3: Apply Mendelian and non-Mendelian inheritance principles to solve genetic

problems, including gene interactions, linkage, and maternal inheritance.
CLO4: Analyze the types and causes of mutations, mechanisms of sex determination, and patterns of mitochondrial and complex inheritance in plants and animals.
CLO5: Evaluate population genetics concepts, Hardy-Weinberg equilibrium, genetic drift, and assess inherited genetic disorders in humans.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: I**
Credits: 3 L 3 T 0 P 0	**Subject: Minor I**
Course Code: BSBI-102	Title: Biochemistry

Course Objectives:
CO1: Understand the basic structure, properties, and biological roles of biomolecules such as carbohydrates, lipids, proteins, and nucleic acids.
CO2: Explain enzyme structure, classification, catalytic mechanisms, enzyme kinetics, and regulation.
CO3: Describe the basic concepts of bioenergetics and metabolic pathways of carbohydrates, lipids, proteins, and nucleotides.
CO4: Analyze the structure and functions of biological membranes and mechanisms of membrane transport.
CO5: Evaluate the clinical significance of biochemical processes and their relevance in human health and disease.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Introduction to Biochemistry and its scope. **Carbohydrates:** Classification, structure, functions of monosaccharides, disaccharides, polysaccharides. **Lipids:** Classification, structure, functions of simple, compound, and derived lipids. **Proteins:** Amino acids, peptide bonds, structural levels of proteins, functions of proteins. **Nucleic Acids:** DNA and RNA – Structure, types, biological functions.	**12**
Unit II	Nomenclature and classification of enzymes (IUB system). Properties of enzymes and mechanism of enzyme action. Enzyme kinetics: Michaelis-Menten equation, factors affecting enzyme activity. Enzyme inhibition: Competitive, non-competitive, uncompetitive. Coenzymes, cofactors, isoenzymes, and enzyme regulation.	**12**
Unit III	Basic principles of bioenergetics, free energy changes, high-energy compounds (ATP). Overview of metabolic pathways: Carbohydrate metabolism: Glycolysis, Gluconeogenesis, TCA cycle,	**12**

	Glycogen metabolism. Lipid metabolism: β-oxidation of fatty acids, ketone bodies. Protein metabolism: Transamination, deamination, urea cycle. Nucleotide metabolism: Purine and pyrimidine synthesis and degradation.	
Unit IV	Structure of biological membranes: Fluid mosaic model. Membrane lipids, membrane proteins, and membrane carbohydrates. Transport mechanisms across membranes: Passive diffusion, facilitated diffusion, active transport, endocytosis, exocytosis. Membrane potential and ion channels.	**12**
Unit V	Overview of clinical biochemistry and its importance. Biochemical basis of diseases: Diabetes mellitus, atherosclerosis, gout, phenylketonuria. Liver function tests, renal function tests, lipid profile tests, and glucose tolerance tests. Antioxidants, free radicals, and their significance in human health.	**12**

Text Book & References :

Text:

Satyanarayana, U., & Chakrapani, U. — Biochemistry (Elsevier)

Jain, J. L., Jain, S., & Jain, N. — Fundamentals of Biochemistry (S. Chand)

Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. — Textbook of Biochemistry for Medical Students (Jaypee Brothers)

References:

Lehninger, A. L., Nelson, D. L., & Cox, M. M. — *Principles of Biochemistry* (W. H. Freeman)

Berg, J. M., Tymoczko, J. L., & Gatto, G. J. — *Biochemistry* (W. H. Freeman)

Voet, D., & Voet, J. G. — *Biochemistry* (Wiley)

Murray, R. K., et al. — *Harper's Illustrated Biochemistry* (McGraw Hill)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the structural features and biological functions of carbohydrates, lipids, proteins, and nucleic acids.

CLO2: Explain the principles of enzyme action, enzyme kinetics, and regulation mechanisms.

CLO3: Interpret energy production and metabolism of biomolecules, emphasizing integration and regulation.

CLO4: Analyze the composition and functions of biological membranes and membrane transport systems.

CLO5: Evaluate the clinical applications of biochemistry in understanding human diseases and diagnostic procedures.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: I**
Credits: 2 L 0 T 0 P 4	**Subject: Practical I (based on Major I)**
Course Code: BSBI-101P	Title: Cell Biology and Genetics Lab

Course Objectives:

CO1: To demonstrate the basic microscopic techniques for studying cells and chromosomes.
CO2: To identify and study the structure and organization of various cell organelles.
CO3: To perform experiments related to cell division and chromosome behavior during mitosis and meiosis.
CO4: To solve genetics problems based on Mendelian inheritance and gene interaction.
CO5: To analyze genetic traits in populations and study the impact of mutations.

Nature of Paper: Core Course Practical

Minimum Passing Marks/Credits: 40%

List of Practical

1. **Study of Compound Microscope:** Principle, parts, and focusing techniques.
2. **Observation of Prokaryotic and Eukaryotic Cells** (Bacteria, Plant, and Animal Cells) using prepared slides.
3. **Cell Organelles Staining:** Staining of mitochondria and nucleus in plant cells (e.g., onion root tips / squamous epithelium).
4. **Plasma Membrane Osmosis Experiment:** Study of plasmolysis in onion peel cells.
5. **Study of Mitosis:** Squash preparation of onion root tips to observe stages of mitosis.
6. **Study of Meiosis:** Observation of meiosis stages from flower buds (e.g., *Tradescantia* or *Rhoeo*).
7. **Mendelian Genetics Problems:** Solving monohybrid and dihybrid crosses, including incomplete dominance and codominance.
8. **Blood Group Testing:** Determination of ABO and Rh blood groups using slide agglutination test.
9. **Study of Chromosomal Aberrations:** Observation of Karyotypes showing Down syndrome, Klinefelter syndrome, and Turner syndrome (using images or charts).

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Demonstrate microscopic techniques to study cells, organelles, and chromosomes.
CLO2: Identify stages of mitosis and meiosis through practical observation.
CLO3: Solve Mendelian and non-Mendelian genetic problems through experimental and theoretical approaches.
CLO4: Analyze human inheritance patterns, chromosomal abnormalities, and blood group systems.
CLO5: Apply population genetics principles experimentally to study genetic variations.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: I**
Credits: 3 L 3 T 0 P 0	**Subject: Multidisciplinary**
Course Code: M-DIS-BMI	Title: Biomedical Informatics

Course Objectives:

On successful completion of this course, learners will be able to:

CO1: Introduce the foundations of biomedical informatics and its interdisciplinary role in healthcare and life sciences.

CO2: Explain key biomedical data types, standards, and databases used in clinical and molecular research.

CO3: Describe the principles of electronic health records (EHR), data storage, and clinical decision support systems.

CO4: Demonstrate understanding of bioinformatics tools for disease gene discovery, medical imaging, and drug informatics.

CO5: Discuss ethical, privacy, and regulatory issues related to biomedical data management and patient information.

Nature of Paper: Multidisciplinary Course

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Biomedical Informatics** • Definition, scope, and importance of biomedical informatics. • Relationship between bioinformatics, medical informatics, and health informatics. • Components of biomedical informatics: data, people, technology, and decision-making. • Overview of applications in medicine, genomics, and public health.	**12**
Unit II	**Biomedical Data and Databases** • Types of biomedical data: molecular, clinical, imaging, and epidemiological data. • Data representation, formats, and standards (HL7, FHIR, DICOM). • Key biomedical databases: PubMed, OMIM, ClinVar, dbSNP, DrugBank, and MeSH. • Data integration and interoperability in healthcare.	**12**
Unit III	**Electronic Health Records (EHR) and Clinical Decision Support Systems (CDSS)** • Structure and components of an EHR system. • Data entry, retrieval, and storage. • Introduction to CDSS: knowledge-based and machine learning-based systems. • Use of informatics in patient monitoring, diagnosis, and treatment planning.	**12**
Unit IV	**Biomedical Tools and Applications** • Bioinformatics tools for disease gene identification and biomarker discovery. • Introduction to imaging informatics and analysis (e.g., MRI, CT data formats).	**12**

	• Pharmacoinformatics: drug databases and virtual screening basics. • Case studies: AI-based diagnostics, telemedicine, and wearable health devices.	
Unit V	**Ethical, Legal, and Social Issues in Biomedical Informatics** • Data privacy, confidentiality, and patient consent. • Ethical issues in AI-driven healthcare. • Intellectual property and data sharing policies. • National and global initiatives in health informatics (India Stack, WHO eHealth).	**12**

Suggested Reading Books

1. Shortliffe, E. H., & Cimino, J. J. — *Biomedical Informatics: Computer Applications in Health Care and Biomedicine* (Springer)
2. Kulkarni, A., & Kelkar, R. — *Introduction to Bioinformatics and Biomedical Informatics* (Springer Nature)
3. Hoyt, R. E., & Yoshihashi, A. — *Health Informatics: Practical Guide* (Lulu Press)
4. Jensen, P. B., Jensen, L. J., & Brunak, S. — *Mining Electronic Health Records: Towards Better Research and Healthcare* (Nature Reviews Genetics, 2012)
5. Detmer, D. E. — *Building the National Health Information Infrastructure for Personal Health, Health Care, Public Health, and Research* (BMC Medical Informatics)
6. Masic, I. — *History and Principles of Medical Informatics* (Avicena, 2017)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the foundational principles, scope, and components of biomedical informatics.

CLO2: Describe major biomedical data types, standards, and databases used in healthcare research.

CLO3: Demonstrate understanding of EHR systems and clinical decision support tools.

CLO4: Apply basic informatics concepts in analyzing biomedical data and digital health applications.

CLO5: Evaluate ethical and legal considerations in biomedical data handling and AI-based healthcare.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: I**
Credits: 3 L 3 T 0 P 0	**Subject: Skill Enhancement Course**
Course Code: SEC-FML	Title: Fundamentals of Machine Learning

Course Objectives:

On successful completion of this course, learners will be able to:

CO1: Understand the basic concepts, terminologies, and workflow of machine learning (ML).
CO2: Explain types of machine learning algorithms and their applications in life sciences.
CO3: Apply basic ML techniques to small biological or clinical datasets using open-source tools.
CO4: Interpret model outputs and evaluate model performance using suitable metrics.
CO5: Recognize ethical, practical, and societal implications of ML in bioinformatics and healthcare.

Nature of Paper: Skill Enhancement Course

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Machine Learning** • Definition, history, and importance of ML. • Key concepts: data, features, labels, training, testing, validation. • Types of ML: supervised, unsupervised, reinforcement learning. • ML workflow and pipeline. • Applications of ML in bioinformatics, genomics, and healthcare. **Introduction to Machine Learning** • Definition, history, and importance of ML. • Key concepts: data, features, labels, training, testing, validation. • Types of ML: supervised, unsupervised, reinforcement learning. • ML workflow and pipeline. • Applications of ML in bioinformatics, genomics, and healthcare.	**12**
Unit II	**Data Handling and Preprocessing** • Types of biological and biomedical data. • Data collection, cleaning, normalization, and feature scaling. • Handling missing values and data imbalance. • Data visualization: histograms, scatter plots, and correlation heatmaps. • Introduction to Python-based ML libraries: NumPy, pandas, scikit-learn.	**12**
Unit III	**Supervised Learning Algorithms** • Concept of training and testing datasets. • Regression models: Linear Regression, Logistic Regression. • Classification models: k-Nearest Neighbors (k-NN), Decision Trees, Naïve Bayes. • Model evaluation: confusion matrix, accuracy, precision, recall, F1-score.	**12**
Unit IV	**Unsupervised Learning and Model Evaluation** • Clustering: k-Means, Hierarchical Clustering. • Dimensionality reduction: Principal Component Analysis (PCA). • Overfitting and underfitting. • Cross-validation and performance improvement techniques. • Case studies in bioinformatics: gene expression clustering, protein classification.	**12**
Unit V	**Emerging Trends and Ethical Considerations** • Introduction to Deep Learning (conceptual overview of Neural	**12**

	Networks). • Applications of AI/ML in personalized medicine, drug discovery, and agriculture. • Open-source ML tools: Orange Data Mining, Google Teachable Machine. • Ethical and societal aspects of AI in healthcare: data privacy, bias, transparency. • Future scope and career opportunities in ML for life sciences.	

Suggested Reading Books

1. Aurélien Géron — *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow* (O'Reilly).
2. Alpaydin, E. — *Introduction to Machine Learning* (MIT Press).
3. Andreas C. Müller & Sarah Guido — *Introduction to Machine Learning with Python* (O'Reilly).
4. Bishop, C. M. — *Pattern Recognition and Machine Learning* (Springer).
5. Hastie, T., Tibshirani, R., & Friedman, J. — *The Elements of Statistical Learning* (Springer).
6. Russell, S. & Norvig, P. — *Artificial Intelligence: A Modern Approach* (Pearson).
7. Tutorials/Documentation: scikit-learn, Orange Data Mining, Google Teachable Machine.

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the foundational principles and terminology of machine learning.
CLO2: Describe major machine learning algorithms and their relevance in life sciences.
CLO3: Demonstrate basic implementation of ML techniques on simple datasets using open-source tools.
CLO4: Interpret and evaluate ML models using standard performance metrics.
CLO5: Discuss ethical implications and career opportunities in ML applications for bioinformatics and healthcare.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: I**
Credits: 3 L 3 T 0 P 0	**Subject: VAC**
Course Code: VAC-AILS	Title: AI for Life Sciences

Course Objectives:

On successful completion of this course, learners will be able to:
CO1: Explain fundamental AI and ML concepts relevant to life sciences.
CO2: Identify and apply AI tools to analyze biological and clinical data.
CO3: Perform beginner-level AI experiments using open-source platforms.

CO4: Evaluate real-world case studies of AI in biology, healthcare, and agriculture.
CO5: Recognize ethical considerations and future career opportunities in AI for life sciences.

Nature of Paper: Value Added Course

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to AI and Life Sciences** • Basics of AI, ML, and DL (conceptual understanding). • Importance of AI in modern biology, healthcare, agriculture, and biotechnology. • **AI tools overview**: Google Teachable Machine, IBM Watson for Health, BioBERT.	**12**
Unit II	Biological Data and AI • Types of life science data: genomic, proteomic, clinical, imaging. • Introduction to **biological databases** (NCBI, PDB, UniProt, PubMed). • AI tools for biological data: **Galaxy Project (workflow-based analysis), Orange Data Mining (visual ML for bio-data)**.	**12**

Unit III	AI Tools and Techniques in Practice
	• Supervised vs. unsupervised learning (easy examples).
	• **Image-based AI tools**:
	  ○ CellProfiler (cell image analysis).
	  ○ DeepCell (microscopy image segmentation).
	• **Text mining/NLP tools**:
	  ○ PubMedMiner, BioBERT for literature mining.
	• **Prediction tools**:
	  ○ AlphaFold (protein structure prediction).
	  ○ DeepMind's AI models in biology.
		12

Unit IV	Applications of AI in Life Sciences • AI in healthcare: diagnostics, radiology, personalized medicine (Watson Health, Zebra Medical Vision). • AI in drug discovery (Atomwise, Insilico Medicine). • AI in agriculture: plant disease detection apps, drone-based AI imaging. • Case studies: AlphaFold, AI in COVID-19 vaccine development, AI in cancer diagnostics.	**12**

Suggested Reading Books

- Deo, N. (2023). *Artificial Intelligence in Biology and Healthcare*. Springer.
- Ching, T., Himmelstein, D. S., & Beaulieu-Jones, B. K. (2018). *Opportunities and obstacles for deep learning in biology and medicine*. Journal of The Royal Society Interface.
- Camacho, D. M., Collins, K. M., Powers, R. K., Costello, J. C., & Collins, J. J. (2018). *Next-generation machine learning for biological networks*. Cell, 173(7),

1581–1592.
- Libbrecht, M. W., & Noble, W. S. (2015). *Machine learning applications in genetics and genomics*. Nature Reviews Genetics, 16(6), 321–332.
- Tutorials/documentation of tools: Teachable Machine, Galaxy Project, Orange Data Mining, AlphaFold, CellProfiler.

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain fundamental AI and ML concepts relevant to life sciences.
CLO2: Identify and apply AI tools to analyze biological and clinical data.
CLO3: Perform beginner-level AI experiments using open-source platforms.
CLO4: Evaluate real-world case studies of AI in biology, healthcare, and agriculture.
CLO5: Recognize ethical considerations and future career opportunities in AI for life sciences.

SYLLABUS: (SEMESTER: II)

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**		**Year: I** **Semester: II**
Credits: 4 L 4 T 0 P 0		**Subject: Major II**
Course Code: BSBI-201		Title: Fundamentals of Bioinformatics
Course Objectives: **CO1:** Understand the scope, applications, and interdisciplinary nature of bioinformatics. **CO2:** Explain biological databases, data types, and data retrieval methods. **CO3:** Apply sequence alignment and analysis tools to study nucleic acids and proteins. **CO4:** Demonstrate knowledge of molecular phylogenetics, evolutionary analysis, and structural bioinformatics. **CO5:** Evaluate computational tools in genomics, proteomics, and drug discovery.		
Nature of Paper: Core Course Theory		
Minimum Passing Marks/Credits: 40%		
Unit	**Content**	**Lecture**
Unit I	Definition, Scope, and History of Bioinformatics. Applications in Modern Biology and Medicine. Interdisciplinary Nature of Bioinformatics. Overview of Genomics and Proteomics. Role of Bioinformatics in Drug Design and Personalized Medicine.	**12**
Unit II	Introduction to Biological Databases: Primary, Secondary, and Specialized Databases. Nucleotide Sequence Databases: GenBank, EMBL, DDBJ. Protein Sequence Databases: UniProt, SWISS-PROT, PIR. Structural Databases: Protein Data Bank (PDB), SCOP, CATH. Data Retrieval Tools: Entrez, SRS, and BLAST Search Interfaces.	**12**
Unit III	Concept of Sequence Alignment: Local vs. Global Alignment. Pairwise Sequence Alignment: Dot Matrix, Dynamic Programming, Needleman-Wunsch, Smith-Waterman Algorithms. Multiple Sequence Alignment: ClustalW, MUSCLE. Scoring Matrices: PAM, BLOSUM. Homology, Similarity, and Identity in Sequences, BLAST and FASTA.	**12**
Unit IV	Phylogenetic Tree Construction Methods: UPGMA, Neighbor-Joining, Maximum Parsimony. Applications of Phylogenetic Analysis in Evolutionary Biology. Protein Structure Prediction: Primary to Quaternary Structure. Secondary Structure Prediction Tools: Chou-Fasman, GOR. Molecular Visualization Tools: RasMol, PyMOL.	**12**
Unit V	Genome Annotation and Gene Prediction Tools. Proteomics Analysis: Protein-Protein Interactions, Protein Docking. Introduction to Systems Biology and Metabolic Pathways. Bioinformatics in Drug Discovery and Vaccine Design.	**12**
Text Book & References : **Text**: Rastogi, S. C., Mendiratta, N., & Rastogi, P. — Bioinformatics: Methods and Applications		

(PHI Learning)
Lesk, A. M. — Introduction to Bioinformatics (Oxford University Press)
Mount, D. W. — Bioinformatics: Sequence and Genome Analysis (Cold Spring Harbor Laboratory Press)

References:
Baxevanis, A. D., & Ouellette, B. F. F. — Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (Wiley-Interscience)
Krawetz, S. A., & Womble, D. D. — Introduction to Bioinformatics: A Theoretical and Practical Approach (Springer)
Claverie, J. M., & Notredame, C. — Bioinformatics for Dummies (Wiley)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:
CLO1: Describe the fundamental concepts, scope, and applications of bioinformatics in biology and medicine.
CLO2: Utilize major biological databases for sequence retrieval, storage, and analysis.
CLO3: Apply sequence alignment techniques for analyzing nucleotide and protein sequences.
CLO4: Interpret phylogenetic trees and predict protein structures using bioinformatics tools.
CLO5: Evaluate the role of bioinformatics in genomics, proteomics, and drug discovery.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: II**
Credits: 3 L 3 T 0 P 0	**Subject: Minor II**
Course Code: BSBI-202	Title: Microbiology

Course Objectives:
CO1: Understand the historical development, scope, and fundamental concepts of microbiology.
CO2: Describe the morphology, structure, and classification of microorganisms.
CO3: Explain microbial nutrition, growth, and reproduction.
CO4: Analyze the role of microorganisms in disease, immunity, and applied microbiology.
CO5: Evaluate laboratory techniques and safety measures used in microbiology.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	**Content**	**Lecture**
Unit I	Introduction and History of Microbiology Contributions of Anton van Leeuwenhoek, Louis Pasteur, Robert Koch, and others Scope of Microbiology: Medical, Industrial, Agricultural,	**12**

	Environmental, and Food Microbiology Overview of Microbial World: Prokaryotic and Eukaryotic Microorganisms	
Unit II	General characteristics and classification of bacteria, fungi, algae, protozoa, and viruses Morphology and ultra-structure of bacteria Cell wall, capsule, flagella, pili, and endospores Virus structure: DNA and RNA viruses	**12**
Unit III	Nutritional types of microorganisms: Autotrophs, Heterotrophs, Chemotrophs Culture media: Types and preparation Growth kinetics and measurement of microbial growth Bacterial reproduction: Binary fission, budding, and sporulation Growth curve and factors affecting growth	**12**
Unit IV	DNA replication, transcription, and translation in prokaryotes Gene transfer methods: Conjugation, transformation, and transduction Mutation: Types and mutagenic agents Microbial metabolism: Fermentation, respiration, and photosynthesis in microorganisms	**12**
Unit V	Microbial diseases: Bacterial (TB, Typhoid), Viral (Hepatitis, AIDS), Fungal (Candidiasis), Protozoal (Malaria) Immunology: Innate and acquired immunity, vaccination Antibiotics: Mode of action and resistance Environmental Microbiology: Role of microbes in biodegradation and bioremediation Food Microbiology: Food spoilage, food preservation, probiotics	**12**

Text Book & References :

Text:

Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. — Microbiology (McGraw Hill)

Prescott, L. M., Harley, J. P., & Klein, D. A. — Microbiology (McGraw Hill Education)

Dubey, R. C., & Maheshwari, D. K. — A Textbook of Microbiology (S. Chand)

References:

Tortora, G. J., Funke, B. R., & Case, C. L. — Microbiology: An Introduction (Pearson)

Madigan, M. T., Bender, K. S., Buckley, D. H., et al. — Brock Biology of Microorganisms (Pearson)

Willey, J. M., Sherwood, L. M., & Woolverton, C. J. — Prescott's Microbiology (McGraw Hill)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the historical developments, scope, and various fields of microbiology.

CLO2: Identify the morphology, classification, and structure of various microorganisms. **CLO3:** Explain microbial nutrition, growth patterns, reproduction methods, and laboratory cultivation. **CLO4:** Analyze microbial genetic mechanisms, metabolism, and gene transfer processes. **CLO5:** Apply knowledge of microbes in medical, industrial, and environmental contexts and demonstrate awareness of laboratory biosafety.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: II**
Credits: 2 L 0 T 0 P 4	**Subject: Practical II (based on Major II)**
Course Code: BSBI-201P	Title: Fundamentals of Bioinformatics Lab
Course Objectives: **CO1:**To introduce the basic tools and techniques used in bioinformatics. **CO2:**To demonstrate database search methods and sequence retrieval. **CO3:**To apply sequence alignment and phylogenetic analysis methods. **CO4:**To perform structure visualization and protein analysis using bioinformatics tools. **CO5:**To explore applications of bioinformatics in genomics, proteomics, and drug discovery.	
Nature of Paper: Core Course Practical	
Minimum Passing Marks/Credits: 40%	
List of Practical	
1. Introduction to NCBI and data retrieval — Accessing NCBI databases and retrieving nucleotide and protein sequences using Entrez search tools. 2. Sequence retrieval from primary databases — Retrieval of nucleotide sequences from GenBank and protein sequences from UniProt/Swiss-Prot databases. 3. BLAST analysis — Performing sequence similarity searches using BLAST (Basic Local Alignment Search Tool) and interpreting the results. 4. Multiple sequence alignment (MSA) — Conducting multiple sequence alignment using Clustal Omega or MUSCLE and identifying conserved regions in sequences. 5. Phylogenetic tree construction — Building phylogenetic trees using aligned sequences through methods such as Neighbor-Joining or UPGMA and analyzing evolutionary relationships. 6. Protein structure visualization — Retrieving protein structures from the Protein Data Bank (PDB) and visualizing 3D structures using tools like RasMol or PyMOL. 7. rotein secondary structure prediction — Predicting secondary structures of proteins using online prediction tools such as Chou-Fasman or GOR. 8. Genome annotation and gene prediction — Using online tools like GENSCAN or Augustus for identifying coding regions and annotating genes within a genomic sequence. 9. Case study on Human Genome Project or drug discovery — Studying case examples from the Human Genome Project or exploring computational drug discovery tools and databases such as DrugBank or molecular docking servers.	
Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10

3) Mid Sem Test 4) End Sem Exam	15 70
Total:	100

Course Learning Outcomes:
CLO1: Demonstrate the use of biological databases and sequence retrieval methods.
CLO2: Apply sequence alignment methods for nucleic acid and protein sequences.
CLO3: Construct and interpret phylogenetic trees based on aligned sequences.
CLO4: Visualize and analyze protein structures using molecular visualization tools.
CLO5: Use bioinformatics tools for genome annotation, gene prediction, and drug discovery analysis.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: II**
Credits: 3 L 4 T 0 P 0	**Subject: Multidisciplinary**
Course Code: M-DIS-IOB	Title: Introduction of Bioinformatics

Course Objectives:
CO1: Understand the scope, applications, and interdisciplinary nature of bioinformatics.
CO2: Explain biological databases, data types, and data retrieval methods.
CO3: Apply sequence alignment and analysis tools to study nucleic acids and proteins.
CO4: Demonstrate knowledge of molecular phylogenetics, evolutionary analysis, and structural bioinformatics.
CO5: Evaluate computational tools in genomics, proteomics, and drug discovery.

Nature of Paper: Multidisciplinary

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Definition, Scope, and History of Bioinformatics. Applications in Modern Biology and Medicine. Interdisciplinary Nature of Bioinformatics.	**12**
Unit II	Introduction to Biological Databases: Primary, Secondary, and Specialized Databases. Nucleotide Sequence Databases: GenBank, EMBL, DDBJ. Protein Sequence Databases: UniProt, SWISS-PROT, PIR.	**12**
Unit III	Concept of Sequence Alignment: Local vs. Global Alignment. Pairwise Sequence Alignment: Dot Matrix, Dynamic Programming, Homology, Similarity, and Identity in Sequences, BLAST and FASTA.	**12**
Unit IV	Phylogenetic Tree Construction Methods: UPGMA, Neighbor-Joining, Maximum Parsimony. Applications of Phylogenetic Analysis in Evolutionary Biology. Protein Structure Prediction: Primary to Quaternary Structure.	**12**
Unit V	Genome Annotation and Gene Prediction Tools. Proteomics Analysis: Protein-Protein Interactions, Protein Docking. Introduction to Systems Biology and Metabolic Pathways. Bioinformatics in Drug Discovery and Vaccine Design.	**12**

Text Book & References :

Text:
Rastogi, S. C., Mendiratta, N., & Rastogi, P. — Bioinformatics: Methods and Applications (PHI Learning)
Lesk, A. M. — Introduction to Bioinformatics (Oxford University Press)
Mount, D. W. — Bioinformatics: Sequence and Genome Analysis (Cold Spring Harbor Laboratory Press)

References:
Baxevanis, A. D., & Ouellette, B. F. F. — Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (Wiley-Interscience)
Krawetz, S. A., & Womble, D. D. — Introduction to Bioinformatics: A Theoretical and Practical Approach (Springer)
Claverie, J. M., & Notredame, C. — Bioinformatics for Dummies (Wiley)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:
CLO1: Describe the fundamental concepts, scope, and applications of bioinformatics in biology and medicine.
CLO2: Utilize major biological databases for sequence retrieval, storage, and analysis.
CLO3: Apply sequence alignment techniques for analyzing nucleotide and protein sequences.
CLO4: Interpret phylogenetic trees and predict protein structures using bioinformatics tools.
CLO5: Evaluate the role of bioinformatics in genomics, proteomics, and drug discovery.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: II**
Credits: 3 L 3 T 0 P 0	**Subject: Skill Enhancement Course**
Course Code: SEC-BSB	Title: Basics of system Biology

Course Objectives:
On successful completion of this course, learners will be able to:
CO1: Introduce the fundamental principles and scope of systems biology in understanding complex biological systems.
CO2: Explain the components, interactions, and network behavior in biological systems at molecular and cellular levels.
CO3: Describe various computational and experimental approaches used to model and analyze biological networks.
CO4: Interpret data integration techniques and visualize system-level interactions using suitable tools.
CO5: Evaluate applications of systems biology in medicine, biotechnology, and personalized healthcare.

Nature of Paper: Skill Enhancement Course		
Minimum Passing Marks/Credits: 40%		
Unit	**Content**	**Lecture**
Unit I	**Introduction to Systems Biology** • Definition, history, and scope of systems biology. • From reductionism to holistic approaches in biology. • Levels of biological organization – molecular, cellular, tissue, and organism. • Importance of integration of genomics, proteomics, metabolomics.	**12**
Unit II	**Components and Interactions in Biological Systems** • Biological networks: genes, proteins, metabolites, and signaling pathways. • Concepts of feedback and feedforward loops, robustness, and modularity. • Gene regulatory networks, protein–protein interaction networks, metabolic networks.	**12**
Unit III	**Modeling and Simulation of Biological Systems** • Mathematical and computational models: deterministic vs. stochastic. • Basic principles of dynamic modeling (ODEs). • Simulation tools overview: CellDesigner, COPASI, Cytoscape.	**12**
Unit IV	**Data Integration and Visualization in Systems Biology** • Sources of systems biology data: databases and repositories (KEGG, BioCyc, Reactome). • Data preprocessing, normalization, and integration. • Network visualization using Cytoscape.	**12**
Unit V	**Applications and Future Directions** • Systems biology in disease modeling, drug discovery, and personalized medicine. • Applications in metabolic engineering and synthetic biology. • Role of AI and machine learning in systems biology. • Ethical and societal implications of systems-level research.	**12**

Suggested Reading Books

1. Alon, U. (2019). *An Introduction to Systems Biology: Design Principles of Biological Circuits.* Chapman & Hall/CRC.
2. Palsson, B. Ø. (2015). *Systems Biology: Simulation of Dynamic Network States.* Cambridge University Press.
3. Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., & Lehrach, H. (2016). *Systems Biology: A Textbook.* Wiley-Blackwell.
4. Kitano, H. (2002). *Foundations of Systems Biology.* MIT Press.
5. Ideker, T., & Lauffenburger, D. (2003). Building with a scaffold: emerging strategies for integrating genomic, proteomic, and metabolomic data. *Cell*, 115(6), 851–854.
6. Nielsen, J. (2017). Systems biology of metabolism. *Annual Review of Biochemistry*, 86, 245–275.

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5

2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the scope, principles, and significance of systems biology as a holistic approach to understanding biological systems.

CLO2: Describe the components and interactions within genetic, metabolic, and signaling networks.

CLO3: Apply basic modeling and simulation concepts to analyze simple biological systems using computational tools.

CLO4: Integrate and visualize biological data from various omics sources for system-level analysis.

CLO5: Evaluate applications of systems biology in disease modeling, biotechnology, and personalized medicine.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: I** **Semester: II**
Credits: 3 L 3 T 0 P 0	**Subject: VAC**
Course Code: VAC-DAFL	Title: Digital and Financial Literacy

Course Objectives:

On successful completion of this course, learners will be able to:

CO1: Understand the basic concepts of digital literacy, online communication, and internet safety.

CO2: Develop essential computer and mobile skills for daily academic and professional use.

CO3: Understand the fundamentals of financial literacy, digital banking, and online transactions.

CO4: Apply knowledge of personal budgeting, savings, and investments for financial well-being.

CO5: Recognize digital security practices, cyber safety, and responsible digital citizenship.

Nature of Paper: Value Added Course

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Digital Literacy** • Basics of computer systems: hardware, software, operating systems. • Understanding the Internet, browsers, and search engines. • Email creation, file sharing, and online communication tools (Google Workspace, MS Teams, Zoom). • Safe internet usage: passwords, privacy, and data protection.	**12**
Unit II	**Digital Skills for Everyday Use** • Working with MS Office / Google Docs, Sheets, and Slides. • Digital collaboration and file storage using cloud services (Google Drive, OneDrive). • Online learning platforms (SWAYAM, Coursera, NPTEL). • Introduction to digital identity and e-Governance services	**12**

	(DigiLocker, Aadhaar-linked services).	
Unit III	**Introduction to Financial Literacy** • Understanding money management: income, expenditure, and budgeting. • Banking basics: types of bank accounts, cheque, ATM, passbook, interest. • Introduction to digital payment systems: UPI, BHIM, Paytm, Google Pay, net banking. • Understanding credit, debit cards, and e-wallets.	**12**
Unit IV	**Financial Planning and Digital Security** • Basics of savings, investment, and insurance. • Introduction to mutual funds, SIP, and government financial schemes. • Cybercrime awareness: phishing, frauds, and secure online practices. • Responsible digital behavior, social media ethics, and maintaining digital wellness.	**12**

Suggested Reading Books

- Ministry of Electronics and Information Technology (MeitY). *Digital Literacy Curriculum (DLC)*, Govt. of India.
- National Centre for Financial Education (NCFE). *Basic Financial Literacy Guide.*
- Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) Study Material.
- Kapoor, Jack. *Personal Finance.* McGraw Hill Education.
- O'Hara, M. E. (2021). *Digital Literacy: Skills for the Connected World.*
- RBI. *Be Aware – Secure Banking Practices*, Reserve Bank of India Publications.

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the basic concepts of digital tools, internet usage, and communication.
CLO2: Demonstrate proficiency in using computers, mobile devices, and cloud-based applications.
CLO3: Understand financial literacy concepts such as budgeting, banking, and digital payments.
CLO4: Apply principles of financial planning and digital transaction security in daily life.
CLO5: Recognize responsible digital behavior, cybersecurity, and online ethics.

YEAR: II

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT														
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE														
Department of Biotechnology														
Course Name - B.Sc. Bioinformatics														
Batch:2025 -26							SEM:III							
S.No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessme	Total	Remark	
				L	T	P		Attendance (5)	quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)			
THEORY and PRACTICAL SUBJECTS														
1	Major 3	BSBI-301	Biological databases and Bioinformatics tools	4	0	0	3	5	10	15	70	100		
2	Major 4	BSBI-302	Introduction to C Programming	4	0	0	3	5	10	15	70	100		
3	Practical 3(Based on Major 3+4)	BSBI-303P	C and Bioinformatics Lab	0	0	4	3	5	10	15	70	100		
4	Minor 3	BSBI-304	Molecular Biology	3	0	0	3	5	10	15	70	100		
5	Multi Disciplinary 3	M-DIS-		3	0	0	3	5	10	15	70	100		
6	Ability Enhancement Course 3 (Disaster Risk Management)	AEC-03	Disaster Risk Management	2	0	0	2	5	10	15	70	100		
7	Skill Enhancement Course 3	SEC-		1	0	3	3	5	10	15	70	100		
TOTAL CREDITS / ASSESSMENT							20	15	30	45	210	300		

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT														
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE														
Department of Biotechnology														
Course Name - B.Sc. Bioinformatics														
Batch:2025 -26							SEM:IV							
S.No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessme	Total	Remark	
				L	T	P		Attendance (5)	quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)			
THEORY and PRACTICAL SUBJECTS														
1	Major 5	BSBI-401	Immunology and Immunotechnology	4	0	0	4	5	10	15	70	100		
2	Major 6	BSBI-402	Genomics and Proteomics	4	0	0	4	5	10	15	70	100		
3	Major 7	BSBI-403	Bioanalytical Techniques	4	0	0	4	5	10	15	70	100		
4	Practical 4 (Based on Major 5+6+7)	BSBI-404P	Immunology , Genomics and Bioanaltycial Techniques Lab	0	0	4	3	5	10	15	70	100		
5	Minor 4	BSBI-405	Web designing using HTML	3	0	0	3	5	10	15	70	100		
6	Ability Enhancement Course 3 (Course on NCC/NSS/NGO,s/ Scout Guide / Sports)	AEC-	Course on NCC/NSS/NGO,s/ Scout Guide / Sports)	2	0	0	2	5	10	15	70	100		
TOTAL CREDITS / ASSESSMENT							20	20	40	60	280	400		

K. V. Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

SYLLABUS (SEMESTER: III)

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: III**
Credits: 3 L 4 T 0 P 0	**Subject: Major III**
Course Code: BSBI-301	Title: Biological databases and Bioinformatics tools

Course Objectives:

CO1: Understand the role, types, and structure of biological databases in bioinformatics.
CO2: Explain various data formats, retrieval methods, and query systems for biological databases.
CO3: Apply key bioinformatics tools for sequence analysis, alignment, and gene identification.
CO4: Demonstrate the use of phylogenetic, structural biology, and molecular modeling tools.
CO5: Evaluate the applications of bioinformatics tools in genomics, proteomics, and drug design.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Definition and importance of biological databases. Types of databases: Primary, Secondary, Composite, Specialized. Overview of Nucleotide Databases: GenBank, EMBL, DDBJ. Protein Databases: UniProt, SWISS-PROT, PIR. Structural Databases: PDB, SCOP, CATH.	**12**
Unit II	Data formats: FASTA, GenBank, EMBL, PDB formats. Database searching tools: Entrez, SRS, DBFetch. Sequence retrieval methods using NCBI tools. Literature databases: PubMed and related tools. File formats and conversion tools.	**12**
Unit III	Sequence alignment basics: Local and Global alignments. Pairwise alignment: Needleman-Wunsch, Smith-Waterman algorithms. Multiple sequence alignment: CLUSTAL Omega, MUSCLE. Scoring matrices: PAM, BLOSUM series. Similarity search tools: BLAST, FASTA.	**12**
Unit IV	Phylogenetic analysis: Tree building methods – UPGMA, Neighbor-Joining. Visualization of Phylogenetic trees: TreeView, MEGA. Protein Structure Visualization: RasMol, PyMOL, Chimera. Secondary Structure Prediction: GOR, Chou-Fasman. Molecular Modeling and Docking Tools: Swiss-Model, AutoDock (Introduction).	**12**
Unit V	Genome annotation and gene prediction tools: GENSCAN, Augustus. Transcriptomics tools: Microarray databases and tools. Proteomics tools: Protein-protein interaction databases, STRING. Drug discovery databases: DrugBank, BindingDB.	**12**

	Case Studies: Human Genome Project, Cancer Genomics Tools.	

Text Book & References :

Text:

Rastogi, S. C., Mendiratta, N., & Rastogi, P. — Bioinformatics: Methods and Applications (PHI Learning)

Lesk, A. M. — Introduction to Bioinformatics (Oxford University Press)

Mount, D. W. — Bioinformatics: Sequence and Genome Analysis (Cold Spring Harbor Laboratory Press)

References:

Baxevanis, A. D., & Ouellette, B. F. F. — Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (Wiley-Interscience)

Krawetz, S. A., & Womble, D. D. — Introduction to Bioinformatics: A Theoretical and Practical Approach (Springer)

Claverie, J. M., & Notredame, C. — Bioinformatics for Dummies (Wiley)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the types, roles, and significance of biological databases in bioinformatics research.

CLO2: Retrieve, interpret, and manage biological data using appropriate tools and formats.

CLO3: Apply sequence alignment tools for nucleic acid and protein analysis.

CLO4: Construct phylogenetic trees and visualize molecular structures using computational tools.

CLO5: Assess the use of bioinformatics tools in modern genomics, proteomics, and drug discovery research.

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: III**
Credits: 3 L 4 T 0 P 0	**Subject: Major IV**
Course Code: BSBI-302	Title: Introduction to C Programming

Course Objectives:

CO1: Understand the basics of C programming, structure, and development environment.

CO2: Develop problem-solving skills using flowcharts, algorithms, and C programming constructs.

CO3: Apply operators, control statements, and functions to solve computational problems.

CO4: Demonstrate knowledge of arrays, strings, pointers, and file handling in C.

CO5: Evaluate and implement modular programming concepts using user-defined functions and structures.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%		
Unit	**Content**	**Lecture**
Unit I	History and Importance of C Language Structure of a C Program Compilation, Execution Process & Basic Syntax Data Types, Variables, Constants Input & Output Functions (printf, scanf, getchar, putchar)	**12**
Unit II	Operators: Arithmetic, Relational, Logical, Assignment, Bitwise, Ternary Type Conversion & Type Casting Conditional Statements: if, if-else, nested if, switch-case Looping: for, while, do-while Break, continue, goto statements	**12**
Unit III	Introduction to Functions: Built-in & User-defined Function Declaration, Definition, and Call Categories of Functions (with/without parameters, with/without return value) Recursion Arrays: One-dimensional and Two-dimensional Arrays	**12**
Unit IV	Strings and String Functions (gets, puts, strlen, strcat, strcmp, strcpy) Pointers: Declaration, Initialization, Dereferencing Pointer Arithmetic, Pointers and Arrays Call by Value & Call by Reference	**12**
Unit V	Structures: Declaration, Initialization, Accessing Members File Handling: File Operations - Opening, Reading, Writing, Closing File Modes and Error Handling Simple File Manipulation Programs	**12**

Text Book & References :

Text:

Kanetkar, Yashavant — Let Us C(BPB Publications)

References:

Balagurusamy, E. — *Programming in ANSI C* (McGraw Hill)

Kernighan, B. W., & Ritchie, D. M. — *The C Programming Language* (PHI)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the structure, syntax, and basic data types of C programming language.

CLO2: Apply decision-making and loop control constructs in C programs.

CLO3: Implement functions and arrays to solve structured programming problems.

CLO4: Manipulate strings and pointers effectively for efficient program execution.

CLO5: Demonstrate the use of structures and file operations in practical C applications.

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: III**
Credits: 3 L 3 T 0 P 0	**Subject: Minor III**
Course Code: BSBI-304	Title: Molecular Biology

Course Objectives:

CO1: Understand the basic concepts of molecular biology, evolution, and cellular structure including prokaryotic and eukaryotic cells.

CO2: Explain the molecular structure and types of genetic material (DNA and RNA) in prokaryotic and eukaryotic organisms.

CO3: Analyze the mechanisms of gene expression regulation and DNA replication in both prokaryotic and eukaryotic cells.

CO4: Illustrate the process of transcription and post-transcriptional modifications in cells.

CO5: Describe the molecular mechanism of protein biosynthesis and its regulation..

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Introduction to molecular biology, Evolution and Molecular structure of cell and its organelles. Types of cells. Including different kinds of prokaryotic and eukaryotic cells. Cell growth, Cell adhesion, cell junctions and extra cellular matrix organelles, Cell cycle, Cell membrane and its structure (fluid-mosaic model). Factors influencing on membrane fluidity, asymmetry of membrane and membrane transport (active and passive).	**12**
Unit II	Molecular Nature of the Genetic Material in Prokaryotic and Eukaryotic Cells: Molecular biology of Genes, DNA: Molecular structure, types: Primary, secondary and tertiary, Double helix, types, Transferring information from DNA to RNA, Synthesis of RNA, Translation RNA: Molecular structure, types. Evolution of DNA and RNA, Gene and genetic codes.	**12**
Unit III	General Concept on Regulation of the Gene Expression, Regulating the Metabolism: The Lac- Operon system, Catabolic repression, Trp Operon system: regulating the biosynthesis of the tryptophan, Gene expression in Eukaryotic cells, Plasmids: types, maintenance and functions. DNA Replication and Gene Expression: DNA Replication: Semi conservative Nature of DNA Replication, DNA Replication in prokaryotic Cells, DNA Replication in Eukaryotic cell, Enzymes involved in DNA Replication: DNA polymerases, Proofreading, post-replication Modification of DNA.	**12**
Unit IV	Transferring information from DNA to RNA, Synthesis of RNA(Transcription), RNA polymerase, Initiation and Termination of Transcription, Post and co- transcription modification of the RNA.	**12**
Unit V	Protein Biosynthesis: Translation of the genetic code, Translation of m RNA, Role of r-RNA in protein synthesis, Forming the polypeptides- elongation, Termination of the protein biosynthesis.	**12**

Text Book & References :

Text:

Watson, J. D., et al. — Molecular Biology of the Gene (Pearson Education)

References:

Lodish, H., et al. — Molecular Cell Biology (W. H. Freeman)

Alberts, B., et al. — Molecular Biology of the Cell (Garland Science)

Lewin, B. — Genes XII (Jones & Bartlett Learning)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the structural and functional organization of cells and their organelles, and explain the properties of the cell membrane and its transport mechanisms.

CLO2: Discuss the molecular nature, structure, and evolution of DNA and RNA, and their roles in genetic information storage and transmission.

CLO3: Explain gene expression regulation mechanisms, operon systems, plasmid functions, and DNA replication processes.

CLO4: Summarize the process of transcription, its regulation, and modifications in prokaryotic and eukaryotic cells.

CLO5: Interpret the steps of protein synthesis, including translation, elongation, and termination processes, and the role of rRNA.

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: III**
Credits: 3 L 0 T 0 P 4	**Subject: Practical III (based on Major III+ IV)**
Course Code: BSBI-303P	Title: C & Bioinformatics Lab

Course Objectives:

CO1: To enable students to retrieve, analyze, and interpret biological data using major bioinformatics databases and tools.

CO2: To provide hands-on experience in sequence alignment, phylogenetic tree construction, and molecular visualization.

CO3: To develop problem-solving abilities through the implementation of computational algorithms using C programming.

CO4: To impart practical knowledge of core C programming concepts such as arrays, functions, pointers, and file handling.

CO5: To integrate the applications of bioinformatics databases and programming skills for solving biological and computational problems effectively.

Nature of Paper: Core Course Practical

Minimum Passing Marks/Credits: 40%

List of Practical	
1. Study and Retrieval of Nucleotide and Protein Sequences Using NCBI Tools (Entrez, GenBank). 2. Study of Protein Databases: Retrieve and Analyze Protein Data from UniProt and SWISS-PROT. 3. Perform Sequence Similarity Search Using BLAST for DNA and Protein Sequences. 4. Perform Multiple Sequence Alignment Using CLUSTAL Omega and Interpret Results. 5. Construction and Visualization of Phylogenetic Trees Using MEGA Software. 6. Write a Program in C to Display "Hello, Bioinformatics!" and Demonstrate Basic I/O Functions. 7. Develop C Program to Perform Arithmetic Operations (Addition, Subtraction, Multiplication, and Division). 8. Write a C program to find prime number, even and odd numbers. 9. Write a C Program to Find the Largest and Smallest Numbers in an Array. 10. Develop C Program to Demonstrate Use of Functions (With and Without Parameters).	
Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance 2) Quiz / PPT / Assignments 3) Mid Sem Test 4) End Sem Exam	5 10 15 70
Total:	100
Course Learning Outcomes: **CLO1:** Retrieve and analyze biological sequences using specialized databases and tools. **CLO2:** Apply sequence alignment and phylogenetic tools for molecular data analysis. **CLO3:** Develop C programs using basic programming constructs and control statements. **CLO4:** Demonstrate the use of functions, arrays, pointers, and file operations in C programming. **CLO5:** Integrate bioinformatics tools and C programming for basic computational biology tasks.	

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: III**
Credits: 3 L 3 T 0 P 0	**Subject: Multidisciplinary**
Course Code: M-DIS-HWD	Title: HTML and Web Designing
Course Objectives: **CO1:** Understand the basic concepts and structure of HTML and its role in web development. **CO2:** Develop skills in creating and formatting web pages using HTML tags and attributes. **CO3:** Apply knowledge of links, images, tables, lists, and forms in HTML-based websites. **CO4:** Demonstrate the ability to design structured and well-organized web pages using frames, multimedia, and embedding techniques. **CO5:** Evaluate and implement fundamental principles of responsive design and accessibility in web development using HTML.	

Nature of Paper: Multidisciplinary		
Minimum Passing Marks/Credits: 40%		
Unit	**Content**	**Lecture**
Unit I	**Introduction to Web Technologies and HTML** • Structure of an HTML document • HTML tags and attributes • Elements and syntax of HTML • Creating a basic webpage	**12**
Unit II	**Text Formatting and Hyperlinks in HTML** • Text formatting tags (bold, italics, underline, etc.) • Font styles and alignment • Creating hyperlinks (internal, external, email links)	**12**
Unit III	**Working with Images, Lists, and Tables in HTML** • Adding and formatting images • Ordered, unordered, and definition lists • Creating and styling tables (rows, columns, borders, merging cells)	**12**
Unit IV	**Forms, Multimedia, and Frames in HTML** • Creating HTML forms (input fields, text areas, buttons, checkboxes, radio buttons, etc.) • Form attributes and validation basics	**12**
Unit V	**Advanced HTML and Accessibility Considerations** • Embedding multimedia (audio, video, YouTube) • Frames and inline frames (iframes) for structured layouts • Best practices for using multimedia and frames	**12**

Text Book & References :

Text:

Bayross, Ivan — HTML, DHTML, JavaScript, Perl & CGI (BPB Publications)

References:

Duckett, Jon — HTML and CSS: Design and Build Websites (Wiley)

Robbins, Jennifer Niederst — Learning Web Design (O'Reilly Media)

Freeman, Elisabeth & Freeman, Eric — Head First HTML and CSS (O'Reilly Media)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the fundamental concepts and structure of HTML for web page development.

CLO2: Create and format web pages with text, hyperlinks, and multimedia using appropriate HTML tags.

CLO3: Develop interactive web pages incorporating forms, images, lists, and tables.

CLO4: Design multi-page websites with effective navigation and structured content layouts.

CLO5: Apply basic responsive design techniques and ensure web accessibility in HTML

projects.

Program: Certificate – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: III**
Credits: 3 L 3 T 0 P 0	**Subject: Skill Enhancement Course**
Course Code: SEC-DD	Title: Drug Designing

Course Objectives:

On successful completion of this course, learners will be able to:

CO1: Understand the fundamental principles, terminology, and scope of drug discovery and design.

CO2: Explain drug–receptor interactions, pharmacodynamics, and pharmacokinetics essential for rational drug design.

CO3: Illustrate the computational approaches used in drug design, including molecular docking and QSAR.

CO4: Explore databases, software, and online resources applied in computer-aided drug design (CADD).

CO5: Evaluate current trends and ethical aspects of drug development and repurposing in the bioinformatics era.

Nature of Paper: Skill Enhancement Course

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Drug Design** • Concept and scope of drug discovery and design. • Basic pharmacological terms: drug, target, lead compound, ligand, receptor. • Drug discovery pipeline: target identification to clinical trials.	**12**
Unit II	**Drug–Target Interactions and Mechanisms** • Types of drug targets: enzymes, receptors, nucleic acids, ion channels. • Drug–receptor interactions: hydrogen bonding, hydrophobic interactions, electrostatic forces. • Introduction to pharmacokinetics (ADME): Absorption, Distribution, Metabolism, Excretion.	**12**
Unit III	**Computational Approaches in Drug Designing** • Structure-based and ligand-based drug design. • Molecular modeling: molecular mechanics and energy minimization. • Molecular docking: principles, scoring functions, interpretation of docking results.	**12**
Unit IV	**Databases and Tools in Drug Designing** • Drug-related databases: DrugBank, PubChem, ChEMBL, ZINC, PDB. • Computational tools and software: AutoDock, PyRx, SwissADME, Discovery Studio (overview). • Virtual screening and lead optimization.	**12**

Unit V	**Applications, Trends, and Ethics** • Computer-aided drug design (CADD) and AI in drug discovery. • Drug repurposing and personalized medicine. • Challenges in drug development: toxicity prediction, validation.	**12**

Suggested Reading Books

1. Patrick, G. L. — *An Introduction to Medicinal Chemistry* (Oxford University Press)
2. Silverman, R. B., & Holladay, M. W. — *The Organic Chemistry of Drug Design and Drug Action* (Academic Press)
3. Singh, J., & Rees, D. C. — *Structure-Based Drug Design* (Springer)
4. Leach, A. R., & Gillet, V. J. — *An Introduction to Chemoinformatics* (Springer)
5. Lengauer, T. — *Bioinformatics – From Genomes to Drugs* (Wiley-VCH)
6. Online Tutorials: AutoDock, PyRx, SwissADME, PubChem, DrugBank

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the basic concepts and stages involved in drug discovery and design.
CLO2: Explain the mechanisms of drug–target interactions and principles of pharmacokinetics and pharmacodynamics.
CLO3: Apply computational methods such as molecular docking and QSAR in theoretical drug design.
CLO4: Utilize databases and software tools used in virtual screening and lead identification.
CLO5: Evaluate ethical and emerging trends in computer-aided drug design and drug development.

SYLLABUS (SEMESTER: IV)

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: IV**
Credits: 4 L 4 T 0 P 0	**Subject: Major V**
Course Code: BSBI-401	Title: Immunology and Immunotechnology

Course Objectives:

CO1: Understand the basic components and mechanisms of the mammalian immune system and immune responses.

CO2: Explain immunoglobulin gene expression, antibody diversity, and the molecular basis of immunologic memory.

CO3: Describe the structure and function of major histocompatibility complexes and apply immuno-techniques for antigen-antibody interactions.

CO4: Analyze various types of vaccines, vaccination methods, and the role of immunization programs in public health.

CO5: Evaluate the mechanisms, diagnosis, and treatment of autoimmune diseases and immune deficiencies, including AIDS.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Immune Response – An Overview** Components of the mammalian immune system, Molecular structure of immunoglobulins or antibodies, Humoral and cellular immune responses, T lymphocytes & immune response (cytotoxic T cells, helper T cells, suppressor T cells), T cell receptors, Genome rearrangements during B lymphocyte differentiation, Antibody affinity maturation and class switching, Assembly of T cell receptor genes by somatic recombination	**12**
Unit II	**Regulation of Immunoglobulin Gene Expression** Clonal selection theory, Allotypes & idiotypes, Allelic exclusion, Immunologic memory, Heavy chain gene transcription, Genetic basis of antibody diversity, Hypotheses: germline & somatic mutation, Antibody diversity, Alternate pathways of transcript splicing, Variable joining sites & somatic mutation, Role of antibody (alone, in complement activation & with effector cells), Monoclonal antibodies	**12**
Unit III	**Major Histocompatibility Complexes (MHC)** Class I & Class II MHC antigens, Antigen processing **Immunity to Infection:** Immunity to different organisms, Pathogen defense strategies, Avoidance of recognition, Inactivation of host immune effector mechanisms **Immuno-Techniques:** Blood grouping, Antigen-Antibody reactions: agglutination, precipitation, immune electrophoresis, Coombs test, ELISA, RIA	**12**
Unit IV	**Vaccines & Vaccination:** Adjuvants, Cytokines, DNA vaccines, Recombinant vaccines,	**12**

	Bacterial vaccines, Viral vaccines, Vaccines to other infectious agents, Tumor vaccines, Principles of vaccination, Passive & active immunization, Immunization programs & role of WHO in immunization programs	
Unit V	**Autoimmune Diseases:** Autoimmunity & autoimmune diseases, Factors contributing to the development of autoimmune diseases, Mechanisms of development, Breakdown of self-tolerance, Rejection of transplants, Molecular mimicry, Diagnosis & treatment of autoimmune diseases, Replacement therapy, Suppression of autoimmune processes, Nature of autoantigens, Immune deficiency, AIDS	**12**

Text Book & References :

Text:

Kuby, J. — Immunology (W.H. Freeman & Company)

Kindt, T.J., Goldsby, R.A., Osborne, B.A. — Kuby Immunology (W.H. Freeman & Company)

References:

Abbas, A.K., Lichtman, A.H., Pillai, S. — Cellular and Molecular Immunology (Elsevier)

Roitt, I., Brostoff, J., Male, D. — Immunology (Mosby)

Janeway, C.A., Travers, P., Walport, M., Shlomchik, M.J. — Immunobiology (Garland Science)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the structural and functional aspects of the immune system and distinguish between humoral and cellular immunity.

CLO2: Analyze the genetic and molecular basis of antibody production, regulation, and diversity.

CLO3: Apply immunological techniques such as ELISA, RIA, and electrophoresis in antigen-antibody studies.

CLO4: Evaluate the principles, types, and applications of various vaccines and immunization strategies.

CLO5: Identify the causes, diagnostic methods, and therapeutic approaches for autoimmune disorders and immune deficiencies.

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: IV**
Credits: 4 L 4 T 0 P 0	**Subject: Major VI**
Course Code: BSBI-402	Title: Genomics and Proteomics

Course Objectives:
CO1: Understand the organization and function of genomes and genes in prokaryotes and eukaryotes.
CO2: Explore methods for genome sequencing, mapping, annotation, and comparative genomics.
CO3: Learn the techniques used in transcriptomics, functional genomics, and proteomics.
CO4: Analyze protein structure, expression, modification, and interaction using proteomics approaches.
CO5: Evaluate applications of genomics and proteomics in disease diagnosis, drug discovery, and personalized medicine.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Genomics** • Definition and scope of genomics • Types of genomes: Prokaryotic and eukaryotic genomes • Genome organization: Chromosome structure, coding and non-coding regions • Mitochondrial and chloroplast genomes • DNA sequencing technologies: Maxam Gilbert, Sanger sequencing, : Shotgun & Hierarchical (clone contig) methods, Next-Generation Sequencing (NGS)	**12**
Unit II	**Genome Mapping and Annotation** • Physical and genetic mapping techniques • Restriction mapping, FISH, STS mapping • Functional elements of genomes: Genes, regulatory regions, promoters, enhancers • Gene prediction and annotation tools • Comparative genomics and its applications • Model organisms in genomics	**12**
Unit III	**Functional Genomics and Transcriptomics** • Transcriptomics: Microarrays • cDNA libraries and ESTs • Gene expression analysis and quantification • Functional genomics: Knockout studies, RNA interference, CRISPR-Cas9 genome editing • Applications in gene function discovery and pathway analysis	**12**
Unit IV	**Introduction to Proteomics** • Definition and significance of proteomics • Protein structure and properties • Protein separation techniques: SDS-PAGE, 2D-PAGE, chromatography • Protein identification and analysis: Mass spectrometry (MALDI-TOF, ESI-MS)	**12**
Unit V	**Advanced Proteomics and Applications** • Protein-protein interaction analysis: Yeast two-hybrid, Co-immunoprecipitation, SPR	**12**

	• Post-translational modifications: Phosphorylation, glycosylation, ubiquitination • Structural proteomics: X-ray crystallography, NMR, Cryo-EM • Applications of proteomics in biomarker discovery, drug development, and personalized medicine • Cancer and Proteomics	

Text Book & References :

Text:

Campbell, A. M., & Heyer, L. J. — Discovering Genomics, Proteomics and Bioinformatics (Benjamin Cummings)

Primrose, S. B., & Twyman, R. M. — Principles of Genome Analysis and Genomics (Blackwell Publishing)

Liebler, D. C. — Introduction to Proteomics: Tools for the New Biology (Humana Press)

References:

Brown, T. A. — Genomes (Garland Science)

Pennington, S. R., & Dunn, M. J. — Proteomics: From Protein Sequence to Function (Viva Books)

Mount, D. W. — Bioinformatics: Sequence and Genome Analysis (Cold Spring Harbor Laboratory Press)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the organization and sequencing of genomes in prokaryotic and eukaryotic organisms.

CLO2: Analyze genome mapping, gene annotation, and comparative genomics methods.

CLO3: Apply transcriptomics and functional genomics techniques for gene function analysis.

CLO4: Demonstrate knowledge of proteomics methods for protein analysis and interactions.

CLO5: Evaluate the applications of genomics and proteomics in clinical, agricultural, and pharmaceutical fields.

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: IV**
Credits: 4 L 4 T 0 P 0	**Subject: Major VII**
Course Code: BSBI-403	Title: Bioanalytical Techniques

Course Objectives:

CO1: Understand the physico-chemical properties of water, pH, buffers, and methods for molecular weight determination.

CO2: Explain the fundamental principles, instrumentation, and applications of spectroscopic techniques in biological studies.
CO3: Learn the principles and applications of centrifugation techniques for macromolecule and subcellular fractionation.
CO4: Understand and apply separation techniques such as chromatography and electrophoresis for biomolecule analysis.
CO5: Explore advanced bio-physical and tracer techniques, including X-ray crystallography, fluorescence, NMR, and radioisotopic methods.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Solutions: Water- Structure and interaction, water as solvent, pH, Bronsted- Lowry concept of acid and bases, ionization, Buffer: Henderson-Hasselbalch equation, biological buffer system (bicarbonate, phosphate buffers and Tris buffers), Determination of molecular weight- molarity, molality, normality, equivalent weight.	**12**
Unit II	Spectroscopy: Colorimetry, Basic principles, Beer-Lamberts law, instrumentation and application of UV-Vis and IR spectroscopy, Centrifugation – Principle & types, sedimentation co-efficient, sedimentation velocity, ultra centrifugation, separation of macromolecules, subcellular fractionation.	**12**
Unit III	Chromatography – Basic principle & types – paper chromatography, thin layer chromatography, column chromatography: gel exclusion, adsorption, ion exchange, affinity. Application of chromatographic technique – separation of biomolecules.	**12**
Unit IV	Electrophoresis – Principle, DNA and RNA gel electrophoresis, Protein gel electrophoresis – SDS PAGE, native-PAGE, documentation, 2D-electrophoresis, Isoelectric focusing. Tracer techniques: nature of radioactivity, isotopes, radioactive decay, α, β and γ radiation, Scintillation counter, application of radioisotopes in biological sample.	**12**
Unit V	Bio-Physical Techniques: Crystallography: basic concepts & laws, symmetry of elements in crystal X–ray crystallography, determination of crystal structure. Fluorescence: concepts, emission, Chemi-luminescence, luminometry. NMR-2D & 3D structure prediction.	**12**

Text Book & References :
Text:
Upadhyay, A., Upadhyay, K., & Nath, N. — Biophysical Chemistry: Principles and Techniques (Himalaya Publishing House)
Rastogi, S.C. — Biophysics and Biophysical Chemistry (New Age International Publishers)
Wilson, K., & Walker, J. — Principles and Techniques of Biochemistry and Molecular Biology (Cambridge University Press)

References:
Lehninger, A. L., Nelson, D. L., & Cox, M. M. — Principles of Biochemistry (W.H. Freeman)

Voet, D., Voet, J. G., & Pratt, C. W. — Fundamentals of Biochemistry (John Wiley & Sons) P.S. Khandare — Introduction to Instrumental Methods of Analysis (Nirali Prakashan) Keith Wilson & John Walker — Practical Biochemistry: Principles & Techniques (Cambridge University Press)	
Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance 2) Quiz / PPT / Assignments 3) Mid Sem Test 4) End Sem Exam	5 10 15 70
Total:	100

Course Learning Outcomes:

CLO1: Explain the structure and interactions of water, pH concepts, buffering systems, and perform calculations involving molarity, molality, and equivalent weight.

CLO2: Apply the principles of UV-Vis, IR spectroscopy, and colorimetry for biomolecular analysis.

CLO3: Demonstrate the use of centrifugation techniques for separation of macromolecules and organelles.

CLO4: Utilize chromatography and electrophoresis methods for qualitative and quantitative analysis of biomolecules.

CLO5: Analyze biological structures using bio-physical techniques like crystallography, fluorescence, NMR, and apply tracer techniques in biological research.

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: IV**
Credits: 3 L 3 T 0 P 0	**Subject: Minor IV**
Course Code: BSBI-405	Title: Web designing using HTML

Course Objectives:

CO1: Understand the basic concepts and structure of HTML and its role in web development.

CO2: Develop skills in creating and formatting web pages using HTML tags and attributes.

CO3: Apply knowledge of links, images, tables, lists, and forms in HTML-based websites.

CO4: Demonstrate the ability to design structured and well-organized web pages using frames, multimedia, and embedding techniques.

CO5: Evaluate and implement fundamental principles of responsive design and accessibility in web development using HTML.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Web Technologies and HTML** • Basics of Internet and Web Technologies • Structure of an HTML document • HTML tags and attributes • Elements and syntax of HTML • Creating a basic webpage	**12**

	• Headings, paragraphs, line breaks, horizontal rules • Comments in HTML	
Unit II	**Text Formatting and Hyperlinks in HTML** • Text formatting tags (bold, italics, underline, etc.) • Font styles and alignment • Creating hyperlinks (internal, external, email links) • Anchors and navigation within web pages • Inserting special characters and symbols	**12**
Unit III	**Working with Images, Lists, and Tables in HTML** • Adding and formatting images • Image attributes (alt text, height, width, alignment) • Ordered, unordered, and definition lists • Creating and styling tables (rows, columns, borders, merging cells) • Table captions and accessibility considerations	**12**
Unit IV	**Forms, Multimedia, and Frames in HTML** • Creating HTML forms (input fields, text areas, buttons, checkboxes, radio buttons, etc.) • Form attributes and validation basics • Embedding multimedia (audio, video, YouTube) • Frames and inline frames (iframes) for structured layouts • Best practices for using multimedia and frames	**12**
Unit V	**Advanced HTML and Accessibility Considerations** • Introduction to semantic HTML elements • Meta tags and SEO basics • Responsive design principles (overview) • Accessibility features (alt text, ARIA roles, keyboard navigation) • Project: Design a multi-page website using all covered topics	**12**

Text Book & References :

Text:

Bayross, Ivan — HTML, DHTML, JavaScript, Perl & CGI (BPB Publications)

References:

Duckett, Jon — HTML and CSS: Design and Build Websites (Wiley)

Robbins, Jennifer Niederst — Learning Web Design (O'Reilly Media)

Freeman, Elisabeth & Freeman, Eric — Head First HTML and CSS (O'Reilly Media)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the fundamental concepts and structure of HTML for web page development.

CLO2: Create and format web pages with text, hyperlinks, and multimedia using appropriate

HTML tags.
CLO3: Develop interactive web pages incorporating forms, images, lists, and tables.
CLO4: Design multi-page websites with effective navigation and structured content layouts.
CLO5: Apply basic responsive design techniques and ensure web accessibility in HTML projects.

Program: Diploma – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: II** **Semester: IV**
Credits: 3 L 0 T 0 P 4	**Subject: Practical IV (based on Major V + VI + VII)**
Course Code: BSBI-404P	Title: Immunology , Genomics and Bioanaltycial Techniques Lab

Course Objectives:
CO1: Understand the components, cells, organs, and molecular mechanisms of the immune system and its immune responses.
CO2: Explain the molecular mechanisms of antibody gene expression, antibody diversity, and immunologic memory.
CO3: Demonstrate the structural and functional significance of MHC complexes and apply key immuno-techniques for antigen-antibody interactions.
CO4: Analyze various vaccination methods, types of vaccines, and understand the importance of immunization programs.
CO5: Evaluate autoimmune disorders, mechanisms of immune tolerance breakdown, transplantation immunology, immune deficiency, and AIDS.

Nature of Paper: Core Course Practical

Minimum Passing Marks/Credits: 40%

List of Practical

1. Prepare phosphate buffer and Tris buffer; calculate and adjust pH using Henderson-Hasselbalch equation.
2. Demonstrate Beer-Lambert's law for protein solutions and measure absorbance using colorimetry.
3. Perform paper chromatography for separation and identification of components from biological samples.
4. Extract genomic DNA from plant cells and separate it using agarose gel electrophoresis.
5. Isolate proteins from biological samples and analyze their molecular weight through SDS-PAGE.
6. Digest plasmid DNA using restriction enzymes and map fragments using gel electrophoresis.
7. Perform antigen-antibody interaction studies using ELISA technique for detection of specific proteins.
8. Perform Blood Grouping (ABO and Rh Typing) Using Slide Agglutination Method.
9. Demonstrate Antigen-Antibody Precipitation Reaction by Double Immunodiffusion (Ouchterlony Method).
10. Perform Agglutination Reaction Using Widal Test for Detection of Typhoid Antibodies.

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the immune system components and explain humoral and cellular immune responses.

CLO2: Analyze the genetic regulation and molecular diversity of antibodies and immunoglobulins.

CLO3: Apply laboratory immuno-techniques for detection and analysis of antigen-antibody interactions.

CLO4: Evaluate different types of vaccines, their principles, and their application in immunization programs.

CLO5: Identify causes, diagnostic methods, and treatments for autoimmune diseases and immune deficiency disorders.

YEAR: III

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Biotechnology

Course Name - B.Sc. Bioinformatics

Batch:2025 -26 — **SEM:V**

S.No.	Course Type	Course Code	Course	Teaching Load			Credits	Internal Assessment			External Assessme	Total	Remark
				L	T	P		Attendance (5)	quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
THEORY and PRACTICAL SUBJECTS													
1	Major 8	BSBI-501	Computational Biology	4	0	0	4	5	10	15	70	100	
2	Major 9	BSBI-502	Biostatistics and R Programming	4	0	0	4	5	10	15	70	100	
3	Practical 5 (Based on Major 8+9)	BSBI-503P	Computational Biology and R programming Lab		0	4	2	5	10	15	70	100	
3	Minor 5	BSBI-504	Plant and Animal Biotechnology	3	0	0	3	5	10	15	70	100	
4	Minor 6	BSBI-505	Bioethics, Biosafety and IPR	3	0	0	3	5	10	15	70	100	
5	Internship	BSBI-506I	Internship	2	0	0	4	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**15**	**30**	**45**	**210**	**300**	

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Biotechnology

Course Name - B.Sc. Bioinformatics

Batch:2025 -26 — **SEM:VI**

S.No.	Course Type	Course Code	Course	Teaching Load			Credits	Internal Assessment			External Assessme	Total	Remark
				L	T	P		Attendance (5)	quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
THEORY and PRACTICAL SUBJECTS													
1	Major 10	BSBI-601	Fundamentals of Programming in PERL	4	0	0	4	5	10	15	70	100	
2	Major 11	BSBI-602	Molecular Modeling and Drug Design	4	0	0	4	5	10	15	70	100	
3	Major 12	BSBI-603	Structural Bioinformatics	4	0	0	4	5	10	15	70	100	
4	Practical 6 (Based on Major 10+11+12)	BSBI-604P	PERL and Molecular Modeling Lab	0	0	4	2	5	10	15	70	100	
5	Minor 7	BSBI-605	Industrial and Environment Biotechnology	3	0	0	3	5	10	15	70	100	
6	Minor 8	BSBI-606	Nanotechnology	3	0	0	3	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**20**	**40**	**60**	**420**	**540**	

K. V. Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

SYLLABUS (SEMESTER: V)

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester:V**
Credits: 4 L 4 T 0 P 0	**Subject: Major VIII**
Course Code: BSBI-501	Title: Computational Biology

Course Objectives:

CO1: Understand the fundamental principles of computational modeling and simulation in biology.

CO2: Learn about algorithmic approaches to biological problem-solving and biological data mining.

CO3: Apply mathematical and statistical modeling for biological system analysis.

CO4: Explore databases and software used for modeling biomolecular interactions and metabolic pathways.

CO5: Develop skills for computational approaches in synthetic biology, evolutionary biology, and population modeling.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Computational Biology** • Definition, scope, and importance of computational biology • Overview of algorithms and databases used in biological sciences • Biological data types: sequence, structure, expression, and interaction data • Applications in genomics, transcriptomics, proteomics, and systems biology • Ethical issues and challenges in computational biology	**12**
Unit II	**Mathematical Foundations of Computational Biology** • Mathematical modeling in biology: Overview • Basic concepts of differential equations in population dynamics and enzyme kinetics • Discrete models: Logistic growth, predator-prey models • Numerical solutions to biological models • Stability analysis of biological systems	**12**
Unit III	**Computational Algorithms for Biology** • Graph theory and its applications in biology • Algorithms for motif finding and pattern matching in DNA/protein sequences • Dynamic programming for biological applications • Machine learning approaches: K-means clustering, Support Vector Machines in biology • Algorithms in structural bioinformatics: Protein folding problem basics	**12**
Unit IV	**Biological Data Mining and Simulation Tools** • Introduction to biological data mining	**12**

	• Principal Component Analysis (PCA) and hierarchical clustering for biological data • Simulation of biochemical reactions using stochastic models • Introduction to agent-based modeling in biological systems • Software for biological simulations: COPASI, CellDesigner	
Unit V	**Modeling of Molecular and Cellular Systems** • Computational models of signal transduction pathways • Metabolic network modeling and flux balance analysis • Gene regulatory network modeling • Tools and databases for pathway modeling: KEGG, Reactome, BioCyc • Case studies on cancer modeling and immune system modeling	**12**

Text Book & References :

Text:

Wilkinson, D. J. — Stochastic Modelling for Systems Biology (CRC Press)

Alon, U. — An Introduction to Systems Biology: Design Principles of Biological Circuits (CRC Press)

References:

De Jong, H. — Modeling and Simulation in Systems Biology (Springer)

Mitchell, M. — An Introduction to Genetic Algorithms (MIT Press)

Klipp, E., Liebermeister, W., Wierling, C., Kowald, A. — Systems Biology: A Textbook (Wiley-VCH)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Apply mathematical models and computational tools for solving biological problems.

CLO2: Utilize algorithmic approaches for analysis of complex biological data sets.

CLO3: Perform simulations and data mining of molecular, cellular, and biochemical systems.

CLO4: Analyze and interpret models of biological networks, pathways, and molecular interactions.

CLO5: Design and implement computational models for evolutionary biology, population dynamics, and synthetic biology.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester: V**
Credits: 4 L 4 T 0 P 0	**Subject: Major IX**
Course Code: BSBI-502	Title: Biostatistics and R Programming

Course Objectives:

CO1: Understand the basic concepts and importance of biostatistics and data types in biological research.

CO2: Apply descriptive statistics, probability distributions, and inferential statistical methods to biological data.

CO3: Demonstrate proficiency in correlation, regression, hypothesis testing, and analysis of variance.

CO4: Develop basic programming skills in R for data analysis, visualization, and statistical computing.

CO5: Integrate biostatistical concepts and R programming for data-driven decision-making and biological research analysis.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Biostatistics and Data Types** • Definition, Scope, and Importance of Biostatistics • Types of Data: Qualitative and Quantitative • Scales of Measurement: Nominal, Ordinal, Interval, and Ratio • Data Collection Methods and Classification • Frequency Distribution, Tabulation, and Graphical Representation (Histogram, Bar Chart, Pie Chart)	**12**
Unit II	**Descriptive Statistics and Probability** • Measures of Central Tendency: Mean, Median, Mode • Measures of Dispersion: Range, Variance, Standard Deviation, Coefficient of Variation • Probability Concepts: Basic Rules, Conditional Probability • Probability Distributions: Binomial, Poisson, Normal • Applications of Probability in Biological Studies	**12**
Unit III	**Inferential Statistics and Hypothesis Testing** • Sampling Methods and Sampling Distribution • Hypothesis Testing: Null and Alternative Hypotheses • t-test, Chi-square test, F-test • Correlation and Regression Analysis • Analysis of Variance (ANOVA): One-way and Two-way ANOVA	**12**
Unit IV	**Introduction to R Programming** • Introduction to R, Installation, and Interface Overview • Basic Syntax, Data Types, Variables, and Operators • Data Structures in R: Vectors, Lists, Matrices, Data Frames, and Factors • Conditional Statements and Loops (if, else, for, while) • Importing and Exporting Data in R (CSV, Excel, TXT)	**12**
Unit V	**Statistical Analysis and Data Visualization Using R** • Descriptive Statistics Using R • Probability Distributions and Simulations in R • Hypothesis Testing in R (t-test, Chi-square, ANOVA) • Correlation and Regression Analysis Using R	**12**

	• Data Visualization Using R: Histograms, Boxplots, Scatterplots, Barplots	

Text Book & References :

Text:

Daniel, W.W. — Biostatistics: A Foundation for Analysis in the Health Sciences (Wiley)

Mathews, J.N.S. — Introduction to Biostatistics (CRC Press)

References:

Crawley, M.J. — Statistics: An Introduction Using R (Wiley)

Dalgaard, P. — Introductory Statistics with R (Springer)

Verzani, J. — Using R for Introductory Statistics (CRC Press)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the fundamental concepts of biostatistics and classify biological data effectively.

CLO2: Apply measures of central tendency, dispersion, and probability distributions to summarize biological data.

CLO3: Perform hypothesis testing, correlation, regression, and ANOVA to analyze biological experiments.

CLO4: Demonstrate the ability to write and execute basic R programs for statistical analysis.

CLO5: Integrate statistical methods with R programming for data visualization and interpretation in biological research.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester: V**
Credits: 3 L 3 T 0 P 0	**Subject: Minor V**
Course Code: BSBI-504	Title: Plant and Animal Biotechnology

Course Objectives:

CO1: Understand fundamental concepts, techniques, and applications in plant and animal biotechnology.

CO2: Demonstrate in vitro techniques such as micropropagation, haploid production, and somatic hybridization in plants, and animal tissue culture methods.

CO3: Apply molecular tools for crop and livestock improvement including transgenesis and gene transfer methods.

CO4: Analyze applications of genome analysis, molecular breeding, gene therapy, and stem cell technologies.

CO5: Evaluate ethical, legal, and practical implications of biotechnology in agriculture, medicine, and conservation.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%		
Unit	**Content**	**Lecture**
Unit I	Introduction to Plant and Animal Biotechnology, Definition and Scope, Classical vs Modern Approaches, Laboratory Organization, Aseptic Techniques, Media Preparation, In Vitro Plant Micropropagation, Shoot Tip Culture, Virus-Free Plant Production, Somaclonal and Gametoclonal Variation, Primary and Secondary Animal Cell Cultures, Continuous Cell Lines, Growth Kinetics, Selection and Applications in Crop and Animal Improvement.	**12**
Unit II	Haploid production techniques in plants (anther, microspore, gynogenesis), protoplast isolation and fusion, somatic hybridization, cybrids, artificial insemination, IVF, animal cloning, embryo transfer, and conservation techniques.	**12**
Unit III	Molecular markers (RAPD, SSR, SNP), marker-assisted selection, QTL mapping, molecular farming (vaccines, nutraceuticals), gene transfer methods in animals (physical, chemical, viral), transgenic animals, and disease resistance applications.	**12**
Unit IV	Transgenic crops for herbicide, insect, and disease resistance, plant-based production of vaccines and bio-products, genome analysis, Human Genome Project, gene therapy, CRISPR, and genetic engineering in medicine.	**12**
Unit V	Stem cell culture and types (embryonic, adult), medical applications of stem cells, stem cell therapy, ethical, legal, and social issues related to stem cells, genetic engineering, and cloning in plants and animals.	**12**

Text Book & References :

Text:

Dubey, R.C. — A Textbook of Biotechnology

Singh, B.D. — Biotechnology: Expanding Horizons

Satyanarayana, U. — Biotechnology

References:

Primrose, S.B. & Twyman, R.M. — Principles of Gene Manipulation and Genomics

Glick, B.R. & Pasternak, J.J. — Molecular Biotechnology

Freshney, R.I. — Culture of Animal Cells

Brown, T.A. — Gene Cloning and DNA Analysis

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain core principles and laboratory techniques of plant and animal biotechnology.

CLO2: Apply tissue culture, haploid production, protoplast fusion, and animal cloning techniques.

CLO3: Utilize molecular markers, genetic engineering, and gene transfer technologies for improvement of plants and animals. **CLO4:** Integrate knowledge of genome projects, gene therapy, and stem cell applications in biotechnology. **CLO5:** Assess biotechnological advancements and related ethical concerns in agriculture, healthcare, and conservation.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**		**Year: III** **Semester: V**
Credits: 3 L 3 T 0 P 0		**Subject: Minor VI**
Course Code: BSBI-505		Title: Bioethics, Biosafety and IPR
Course Objectives: **CO1:** Understand the fundamental principles of biosafety, risk assessment, and biosafety regulations in biotechnological research. **CO2:** Analyze ethical, legal, and social issues related to biotechnology, including human cloning and stem cell research. **CO3:** Explain the process of patenting, its requirements, procedures, and its significance in the protection of biotechnological inventions. **CO4:** Understand the national and international regulatory frameworks governing GMOs, food safety, and transgenic research. **CO5:** Develop project management skills for biotechnology ventures, including project formulation, financial analysis, and funding sources.		
Nature of Paper: Core Course Theory		
Minimum Passing Marks/Credits: 40%		
Unit	**Content**	**Lecture**
Unit I	Biosafety: Introduction, Historical prospective, objectives, risk assessment in biotechnological research and their regulation, physical and biological contaminants, field trial and planned introduction of GMOs, Biosafety guidelines in India, Biosafety levels for plant, animal and microbial researches.	**12**
Unit II	Bioethics: Introduction, Ethical issues related to biotechnology, legal and socioeconomic impacts of biotechnology, health and safety issues, possible benefits of successful cloning, Ethical concerns of gene cloning, hazards of environmental engineering, Ethical issues in Human Cloning and stem cell research.	**12**
Unit III	Patents and patent processing: Introduction, Essential requirements, international scenario of patents, patenting of biological materials, significance of patents in India, Patent application, Procedures and granting, protection of biotechnological inventions, Patent Act (1970), Patent (Amendments) Act (2002).	**12**
Unit IV	Regulatory framework in Biotechnology: Regulation of RDT research, Regulation of food and food ingredients, Regulatory framework in India governing GMOs, Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Prevention Food Adulteration Act (1955), Food Safety and Standards	**12**

	Bill (2005).	
Unit V	Project management: Search for a business idea, concept of project and classification, project identification, project formulation, project design and network analysis, project report, project appraisal. Financial analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process. Funding of biotech business (Financing alternatives, Venture Capital funding, funding for biotech in India.	**12**

Text Book & References :

Text:

Singh, B.D. — *Biotechnology: Expanding Horizons* (Kalyani Publishers)

Sateesh, M.K. — *Bioethics and Biosafety* (IK International Publishing House)

References:

Kankanala, C. — Genetic Patent Law and Strategy (Manupatra Information Solutions)

Krattiger, A.F. et al. — Intellectual Property Management in Health and Agricultural Innovation (MIHR)

David P. Clark & Nanette J. Pazdernik — Biotechnology: Applying the Genetic Revolution (Academic Press)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the concepts of biosafety, risk assessment, and regulatory guidelines in biotechnology research.

CLO2: Analyze ethical and legal issues in modern biotechnology and evaluate the impacts on society and environment.

CLO3: Apply knowledge of patent laws and intellectual property rights for the protection of biotechnological innovations.

CLO4: Interpret and explain national and international biotechnology regulations, including food safety and transgenic guidelines.

CLO5: Formulate and evaluate project proposals with financial analysis for effective management of biotechnology-based ventures.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester: V**
Credits: 2L 0 T 0 P 4	**Subject: Practical V (based on Major VIII + IX)**
Course Code: BSBI-503P	Title: Computational Biology and R programming Lab
Course Objectives:	

CO1: Understand the fundamental concepts of biostatistics, probability, hypothesis testing, and their application in biological research.
CO2: Develop programming skills in R for statistical analysis, data handling, visualization, and reporting.
CO3: Acquire knowledge of computational biology, biological data types, databases, algorithms, and their applications in life sciences.
CO4: Apply mathematical and computational modeling approaches to study biological systems and solve biological problems.
CO5: Utilize biological data mining, simulation tools, and computational models to analyze molecular and cellular systems in biology.

Nature of Paper: Core Course Practical

Minimum Passing Marks/Credits: 40%

List of Practical

1. Create and interpret frequency tables, histograms, and pie charts using R for a biological dataset.
2. Calculate mean, median, mode, standard deviation, and variance for experimental biological data using R.
3. Perform t-test, chi-square test, and ANOVA on gene expression or protein concentration data using R.
4. Build and visualize linear regression and correlation models in R using biological sample datasets.
5. Simulate binomial, Poisson, and normal distributions using R and interpret biological relevance.
6. Implement basic graph theory to represent biological networks (e.g., protein-protein interaction) using R or Python.
7. Model predator-prey or logistic growth using differential equations and solve numerically using R.
8. Perform PCA and hierarchical clustering on gene expression data using R or Python.
9. Use COPASI or CellDesigner to simulate a metabolic pathway or gene regulatory network.
10. Explore KEGG or Reactome database to model and analyze a biological pathway using computational tools.

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:
CLO1: Classify and analyze biological data using descriptive and inferential statistics, and apply hypothesis testing methods.
CLO2: Demonstrate the ability to program in R for biological data analysis, including statistical modeling and visualization.
CLO3: Identify and use computational biology tools and databases for solving problems in genomics, proteomics, and systems biology.
CLO4: Apply mathematical and algorithmic approaches to model biological processes such

as population dynamics, gene regulation, and enzymatic reactions. **CLO5:** Integrate computational simulations and modeling tools for systems-level analysis of biological networks and pathways.

SYLLABUS (SEMESTER: VI)

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester: VI**
Credits: 4 L 4 T 0 P 0	**Subject: Major X**
Course Code: BSBI-601	Title: Fundamentals of Programming in PERL

Course Objectives:

CO1: Understand the basic principles, history, and structure of Perl programming language.
CO2: Develop proficiency in writing Perl scripts for simple data processing tasks.
CO3: Apply Perl programming concepts such as arrays, hashes, file handling, and regular expressions for problem solving.
CO4: Utilize Perl for automating tasks in biological data analysis and text manipulation.
CO5: Integrate Perl programming for bioinformatics applications, including sequence analysis and data parsing.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	History, Features, and Applications of Perl Perl Syntax and Data Types (Scalars, Strings, Numbers) Variables and Operators Input and Output Operations Writing and Executing Simple Perl Scripts	**12**
Unit II	Conditional Statements: if, if-else, unless Looping Constructs: while, until, for, foreach Logical and Comparison Operators Built-in Functions and User-defined Functions Variable Scope and Function Parameters	**12**
Unit III	Arrays: Declaration, Accessing, Manipulation Hashes: Declaration, Accessing, Manipulation Array and Hash Functions Sorting and Slicing Arrays and Hashes References and Complex Data Structures	**12**
Unit IV	File Operations: Opening, Reading, Writing, and Closing Files File Test Operators and Error Handling Pattern Matching and Substitution using Regular Expressions Using Regular Expressions for Text Parsing and Data Extraction Directory Operations and File Globbing	**12**
Unit V	String Manipulation and Sequence Analysis in Perl Parsing Sequence Data Files (FASTA, GenBank, etc.) BioPerl Modules: Overview and Basic Usage	**12**

Text Book & References :

Text:
Schwartz, R.L., Phoenix, T., & foy, B. D. — Learning Perl (O'Reilly Media)
Tisdall, J. — Beginning Perl for Bioinformatics (O'Reilly Media)

References:
Wall, L., Christiansen, T., & Orwant, J. — Programming Perl (O'Reilly Media)
James, T. — Bioinformatics Programming Using Perl (O'Reilly Media)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:
CLO1: Explain the basics of Perl programming, including syntax, data types, and simple script execution.
CLO2: Write Perl programs using conditional structures, loops, and functions for data processing.
CLO3: Apply Perl's data structures (arrays, hashes) and regular expressions for text manipulation tasks.
CLO4: Utilize Perl for file handling and data parsing in computational problems.
CLO5: Develop and apply Perl scripts for bioinformatics applications like sequence analysis and biological data parsing.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester: VI**
Credits: 4 L 4 T 0 P 0	**Subject: Major XI**
Course Code: BSBI-602	Title: Molecular Modeling and Drug Design

Course Objectives:
CO1: Understand the fundamental concepts, principles, and scope of molecular modeling and drug design.
CO2: Apply computational techniques for molecular structure generation, optimization, and visualization.
CO3: Learn the concepts of molecular docking, scoring functions, and virtual screening.
CO4: Analyze pharmacokinetics, pharmacodynamics, QSAR modeling, and ADMET properties.
CO5: Evaluate case studies on drug discovery, lead identification, and development of novel therapeutic agents.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Molecular Modeling and Drug Discovery** • Scope and importance of molecular modeling in drug	**12**

	discovery • Fundamental concepts: Molecular mechanics, Molecular dynamics • Energy minimization, Force fields (MM, AMBER, CHARMM, etc.) • Structure-based drug design vs. Ligand-based drug design • Databases and resources in drug discovery (DrugBank, PubChem, PDB)	
Unit II	**Molecular Structure Building and Visualization Tools** • Molecular structure generation and optimization • Conformational analysis and torsion angles • Molecular visualization techniques (PyMOL, Chimera, Discovery Studio) • Protein-ligand interactions and binding site identification • Homology modeling and protein structure prediction basics	**12**
Unit III	**Molecular Docking and Virtual Screening** • Molecular docking: Principles, Types (rigid, flexible docking) • Scoring functions and validation of docking results • Virtual screening methods and drug-likeness evaluation • Structure-based pharmacophore modeling	**12**
Unit IV	**Pharmacokinetics, Pharmacodynamics, and QSAR** • Introduction to ADMET properties and their importance • Lipinski's Rule of Five and drug-likeness filters • Quantitative Structure-Activity Relationship (QSAR) modeling • Molecular descriptors and statistical modeling • Applications of QSAR in lead optimization	**12**
Unit V	**Applications and Case Studies in Drug Design** • Case studies of FDA-approved drugs and their discovery journey • Target identification and lead optimization strategies • Applications of AI and Machine Learning in Drug Design • Emerging tools for drug repurposing and predictive modeling • Future trends and challenges in computational drug discovery	**12**
Text Book & References : **Text**: Leach, A.R. — Molecular Modelling: Principles and Applications (Pearson Education) Vishweshwar Rao, L. — Molecular Modeling and Drug Design (PharmaMed Press) **References:** Gurunath, R., & Sreeramulu, S. — Computer-Aided Drug Design (Universities Press) Schneider, G., & Baringhaus, K.H. — Molecular Design: Concepts and Applications (Wiley-VCH) Mannhold, R., Kubinyi, H., Folkers, G. — Drug Discovery and Evaluation: Pharmacological Assays (Springer)		
Evaluation/Assessment Methodology		
Max. Marks		

1) Attendance 2) Quiz / PPT / Assignments 3) Mid Sem Test 4) End Sem Exam	5 10 15 70
Total:	100

Course Learning Outcomes:

CLO1: Explain the fundamental principles of molecular modeling and its applications in drug discovery.

CLO2: Apply computational tools for molecular modeling, visualization, and structure optimization.

CLO3: Perform molecular docking, virtual screening, and analyze protein-ligand interactions.

CLO4: Analyze pharmacokinetic properties, QSAR models, and optimize drug-like candidates.

CLO5: Evaluate and interpret real-world case studies of drug discovery and apply modern computational techniques for drug design projects.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester: VI**
Credits: 4 L 4 T 0 P 0	**Subject: Major XII**
Course Code: BSBI-603	Title: Structural Bioinformatics

Course Objectives:

CO1: Understand the fundamental concepts, techniques, and importance of structural bioinformatics in biological research.

CO2: Analyze protein and nucleic acid structures using specialized databases and formats.

CO3: Apply computational methods for protein structure prediction, modeling, and structural alignment.

CO4: Learn molecular docking, molecular dynamics, and visualization tools for analyzing biomolecular interactions.

CO5: Integrate structural bioinformatics approaches for drug discovery, protein engineering, and functional genomics.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Structural Bioinformatics** • Scope and significance of structural bioinformatics • Levels of protein structure: primary, secondary, tertiary, quaternary • Physicochemical forces in biomolecular structures • Protein folding problem and folding pathways • Techniques for structure determination: X-ray crystallography, NMR spectroscopy, Cryo-EM	**12**
Unit II	**Protein Structure Databases and File Formats** • Protein Data Bank (PDB), SCOP, CATH databases • Protein structure file formats: PDB, mmCIF, FASTA	**12**

	• Structure visualization tools: PyMOL, Chimera, RasMol • Secondary structure assignment methods (DSSP, STRIDE) • Ramachandran plot analysis and structure validation	
Unit III	**Structure Prediction and Modeling Techniques** • Homology modeling: Concept, methodology, and tools (MODELLER, SWISS-MODEL) • Threading and fold recognition methods • Ab initio structure prediction approaches • Model validation and quality assessment tools (ProSA, PROCHECK, ERRAT) • Comparative case studies of structure modeling	**12**
Unit IV	**Molecular Docking and Molecular Dynamics Simulations** • Molecular docking principles and applications • Ligand and receptor preparation for docking • Docking tools: AutoDock, GOLD, SwissDock • Introduction to molecular dynamics simulations • Visualization and analysis of molecular interactions	**12**
Unit V	**Applications of Structural Bioinformatics** • Protein-ligand interaction studies in drug discovery • Protein engineering and stability prediction • Functional annotation based on structure • Structure-based virtual screening and pharmacophore modeling • Case studies in disease-related protein analysis	**12**

Text Book & References :

Text:

David M. Webster & Christine Orengo — Structural Bioinformatics (Wiley-Blackwell)

Phil Bourne & Helge Weissig — Structural Bioinformatics (2nd Edition, Wiley-Liss)

References:

Andreas D. Baxevanis & B. F. Francis Ouellette — Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (Wiley)

Gromiha, M. Michael — Protein Bioinformatics: From Sequence to Function (Elsevier)

Hansen, J. et al. — Molecular Modelling: Basic Principles and Applications (Springer)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe the basic principles and structural organization of biomolecules using structural bioinformatics approaches.

CLO2: Utilize databases and visualization tools for retrieving, viewing, and analyzing biomolecular structures.

CLO3: Apply computational techniques for accurate protein structure prediction and validation.

CLO4: Demonstrate proficiency in molecular docking and molecular dynamics for studying biomolecular interactions. **CLO5:** Integrate structural bioinformatics tools for advanced applications in drug discovery and protein function prediction.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester: VI**
Credits: 3 L 3 T 0 P 0	**Subject: Minor VII**
Course Code: BSBI-605	Title: Industrial and Environment Biotechnology

Course Objectives:

CO1: Understand traditional and modern bioenergy sources and their environmental impacts.
CO2: Explore microbial and plant-based technologies for pollution control, bioremediation, and waste management.
CO3: Apply microbial processes for biofertilizer production, waste treatment, and bioconversion of industrial wastes.
CO4: Analyze industrial-scale microbial processes for the production of enzymes, metabolites, and biofuels with biosafety considerations.
CO5: Examine environmental laws, industrial biosafety practices, and intellectual property rights applicable to biotechnology industries.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Bioenergy and Environmental Impact** • Conventional fuels (firewood, coal, gas) vs. modern biofuels • Methanogenic bacteria, biogas, microbial hydrogen production • Bioethanol, gasohol, and sustainable energy alternatives • Microbial fermentation for bioenergy production	**12**
Unit II	**Bioremediation and Waste Treatment** • Microbial degradation of oil spills, heavy metals, pesticides, detergents • Phytoremediation and microbial degradation of lignin, cellulose, hydrocarbons • Bioremediation of industrial effluents and solid waste • Role of biofertilizers (symbiotic/asymbiotic nitrogen fixers, VAM fungi)	**12**
Unit III	**Industrial Fermentation and Bioprocesses** • Microbial diversity in industrial processes • Fermentation types: batch, fed-batch, continuous; fermenter design • Production of alcohols, organic acids, antibiotics, enzymes, and biopolymers • Downstream processing and scaling-up microbial processes	**12**
Unit IV	**Industrial Bioproducts and Applications** • Enzyme technology: production, immobilization, industrial applications	**12**

	• Production of single-cell protein (SCP) & single-cell oil (SCO) • Biofuels: bioethanol, biogas, biodiesel; bioplastics, biodegradable materials • Biocatalysis, biotransformation, and process optimization	
Unit V	**Biosafety, Environmental Regulations, and IPR** • Environmental laws: Wildlife Act (1972), Water Act (1974), Forest Act (1980), Air Act (1981), EPA (1986), Biodiversity Act (2002), Climate Policies • Industrial biosafety, GMP, GLP, quality assurance, waste management • Intellectual Property Rights (IPR) in biotech industries • Case studies: Biocon, Serum Institute, and others	**12**

Text Book & References :

Text:

Rittmann, B.E., McCarty, P.L. — Environmental Biotechnology: Principles and Applications (McGraw Hill)

Crueger, W., Crueger, A. — Biotechnology: A Textbook of Industrial Microbiology (Sinauer Associates)

Singh, B.D. — Biotechnology: Expanding Horizons (Kalyani Publishers)

References:

Evans, G.M., Furlong, J.C. — Environmental Biotechnology: Theory and Application (Wiley)

Stanbury, P.F., Whitaker, A., Hall, S.J. — Principles of Fermentation Technology (Elsevier)

Sateesh, M.K. — Bioethics and Biosafety (IK International)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the environmental implications of traditional and modern biofuels, and microbial bioenergy production.

CLO2: Apply microbial and phytoremediation approaches for environmental cleanup and waste management.

CLO3: Operate and analyze fermentation processes for the production of biofertilizers, metabolites, and bioproducts.

CLO4: Evaluate industrial bioproducts, biofuels, and biocatalytic processes for environmental and industrial applications.

CLO5: Interpret regulatory frameworks, biosafety practices, and IPR relevant to environmental and industrial biotechnology sectors.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester: VI**
Credits: 3 L 3 T 0 P 0	**Subject: Minor VIII**
Course Code: BSBI-606	Title: Nanotechnology

Course Objectives:

CO1: Understand the basic principles, history, and significance of nanobiotechnology in life sciences and medicine.

CO2: Explain the properties, synthesis, and characterization of nanoparticles used in biological applications.

CO3: Analyze the applications of nanomaterials in drug delivery, diagnostics, and therapeutic innovations.

CO4: Evaluate advanced applications of nanomedicine including artificial blood, immunotoxins, and cyclic peptides.

CO5: Explore emerging technologies such as biosensors, DNA computers, molecular motors, and hybrid materials within nanobiotechnology.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Introduction to nanobiotechnology- From Biotechnology to Bionanotechnology- Bionanomachines in action-Modern Biomaterials – The Legacy of Evolution	**12**
Unit II	Bimolecular Design and Biotechnology- Recombinant DNA technology-Monoclonal Antibodies-Biomolecular structure determination- Molecular Medicine.	**12**
Unit III	Functional Principles of Nanobiotechnology- Information Driven NanoAssembly-Energetics- Chemical Transformation-Regulation Biomolecular Motors BiomolecularSensing-Self- Replication-Machine–Phase Bionanotechnology.	**12**
Unit IV	Nanomedicine- Anti-AIDS drugs-Immunotoxins as cell killers-Artificial blood- Cyclic peptides from nanotubes.	**12**
Unit V	Applications of Nanobiotechnology - Harnessing molecular Motors-DNA computers- Molecular design using biological selection-Artificial Life-Hybrid Materials-Biosensors.	**12**

Text Book & References :

Text:

K.K. Jain — Nanobiotechnology: Applications, Markets, and Commercialization (Springer)

C.M. Niemeyer & C.A. Mirkin — Nanobiotechnology: Concepts, Applications and Perspectives (Wiley-VCH)

References:

Robert A. Freitas Jr. — Nanomedicine, Volumes I & II (Landes Bioscience)

Murat Ozkaya et al. — Nanotechnology in Health Care (Springer)

Bhushan, Bharat — Springer Handbook of Nanotechnology (Springer)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10

3) Mid Sem Test 4) End Sem Exam	15 70
Total:	100

Course Learning Outcomes:

CLO1: Describe the core concepts, structures, and ethical concerns of nanobiotechnology and its interdisciplinary nature.

CLO2: Apply nanoparticle synthesis and characterization methods for biological and medical applications.

CLO3: Evaluate nanotechnology-based solutions for drug delivery, imaging, and therapeutic applications.

CLO4: Analyze the potential and limitations of nanomedicine, including cutting-edge therapeutics like immunotoxins and artificial blood.

CLO5: Explore advanced nanobiotechnology applications such as biosensors, DNA computing, molecular motors, and artificial life.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: III** **Semester: VI**
Credits: 2 L 0 T 0 P 4	**Subject: Practical VI (based on Major X + XI + XII)**
Course Code: BSBI-604P	Title: PERL and Molecular Modeling Lab

Course Objectives:

CO1: Understand Perl programming fundamentals and its applications in bioinformatics and text parsing.

CO2: Explore the concepts and tools of molecular modeling, energy minimization, and drug discovery techniques.

CO3: Apply molecular docking and virtual screening methods for analyzing drug-target interactions.

CO4: Analyze pharmacokinetic and pharmacodynamic parameters through computational approaches, including QSAR modeling.

CO5: Develop skills to analyze and model biomolecular structures using structural bioinformatics databases, visualization tools, and computational techniques.

Nature of Paper: Core Course Practical

Minimum Passing Marks/Credits: 40%

List of Practical

1. Write and execute Perl scripts for string manipulation, arrays, and hashes for biological datasets.
2. Develop Perl programs for file operations to read/write FASTA and GenBank sequence files.
3. Perform regular expression-based parsing and extraction of sequence motifs from biological data using Perl.
4. Use BioPerl modules to parse sequence data and retrieve biological information from online databases.
5. Generate and optimize molecular structures of small drug-like molecules using molecular modeling software.
6. Visualize molecular structures and analyze conformations using PyMOL or Chimera,

including torsion angle analysis.

7. Perform molecular docking of protein-ligand complexes using AutoDock or SwissDock and analyze binding sites.
8. Evaluate drug-likeness, ADMET properties, and apply Lipinski's Rule using drug discovery software or online tools.
9. Model and validate protein structures using homology modeling tools like SWISS-MODEL or MODELLER and Ramachandran plot analysis.
10. Analyze protein-ligand interactions through case studies of disease-related proteins using structural bioinformatics tools.

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Write and execute Perl scripts for biological data analysis, file handling, and text parsing using regular expressions and BioPerl modules.

CLO2: Apply molecular modeling tools for structure generation, optimization, and visualization in drug discovery research.

CLO3: Perform molecular docking, virtual screening, and pharmacophore modeling for drug-target interaction studies.

CLO4: Analyze ADMET properties, apply Lipinski's rule, and develop QSAR models for predicting drug-likeness and activity.

CLO5: Retrieve, visualize, and validate protein structures using structural bioinformatics tools, and apply modeling methods for structural analysis.

YEAR: IV

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT														
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE														
Department of Biotechnology														
Course Name - B.Sc. Bioinformatics														
Batch:2025 -26							SEM:VII							
S.No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessme	Total	Remark	
				L	T	P		Attendance (5)	quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)			
THEORY and PRACTICAL SUBJECTS														
1	Major 13	BSBI-701	Machine Learning in Bioinformatics	4	0	0	4	5	10	15	70	100		
2	Major 14	BSBI-702	Systems Biology	4	0	0	4	5	10	15	70	100		
3	Practical 7 (Based on Major (13+14)	BSBI-703P	Machine Learning and System Biology Lab	0	0	4	2	5	10	15	70	100		
4	Major 15	BSBI-704	Genetic Engineering	4	0	0	4	5	10	15	70	100		
5	Minor 9	BSBI-705	Entrepreneurship in Life Sciences	3	0	0	4	5	10	15	70	100		
6	Practical 8 (Based on Major 15)	BSBI-706P	Genetic Engineering Lab	0	0	4	2	5	10	15	70	100		
TOTAL CREDITS / ASSESSMENT							20	30	60	90	420	600		

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Biotechnology													
Course Name - B.Sc. Bioinformatics													
Batch:2025-26							SEM:VIII						
S.No.	Course Type	Course Code	Course	Teaching Load			CREDITS	Internal Assessment			External Assessme	Total	Remark
	THEORY and PRACTICAL SUBJECTS			L	T	P		Attendance (5)	Quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 16	BSBI-801	Research Methodology in Bioinformatics	4	0	0	4	5	10	15	70	100	
2	Minor 10	BSBI-802	Literature review and Scientific writing	3	0	0	4	5	10	15	70	100	
3	Research Project / Dissertation	BSBI-803RP/DS	Research Project / Dissertation	2	0	0	12				300	300	
TOTAL CREDITS / ASSESSMENT							20	60			440	500	

K. V. Subharti College of Science
S. V. Subharti University
NH-58 Bypass Road, Meerut

SYLLABUS (SEMESTER: VII)

Program: Honors Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: IV** **Semester: VII**
Credits: 4 L 4 T 0 P 0	**Subject: Major XIII**
Course Code: BSBI-701	Title: Machine learning in Bioinformatics

Course Objectives:

CO1: Understand the fundamentals of machine learning and its significance in bioinformatics.

CO2: Analyze various supervised and unsupervised learning algorithms and their applications in biological datasets.

CO3: Apply dimensionality reduction and feature selection techniques for high-dimensional biological data analysis.

CO4: Develop practical skills to implement machine learning models using Python/R for genomic, proteomic, and clinical datasets.

CO5: Integrate advanced machine learning tools for predictive modeling, biological network analysis, and biomarker discovery.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Machine Learning and Bioinformatics Applications** • Basics of Artificial Intelligence and Machine Learning • Difference Between AI, ML, and Deep Learning • Biological Data Characteristics: Genomic, Transcriptomic, Proteomic, and Metabolomic Data • Types of Learning: Supervised, Unsupervised, Reinforcement Learning • Challenges and Opportunities in Machine Learning for Bioinformatics	**12**
Unit II	**Supervised Learning Algorithms for Bioinformatics** • Linear Regression and Logistic Regression • Decision Trees and Random Forests • Support Vector Machines (SVM) • Neural Networks: Basic Concepts • Applications in Disease Classification, Gene Expression Analysis, and Protein Structure Prediction	**12**
Unit III	**Unsupervised Learning and Dimensionality Reduction** • Clustering Methods: K-means, Hierarchical Clustering, DBSCAN • Principal Component Analysis (PCA) • t-Distributed Stochastic Neighbor Embedding (t-SNE) • Feature Selection and Dimensionality Reduction Techniques • Applications in Gene Clustering, Phylogenetics, and Population Studies	**12**
Unit IV	**Machine Learning Tools and Programming for Bioinformatics**	**12**

	• Introduction to Python and R Libraries for Machine Learning (scikit-learn, TensorFlow, Keras, caret) • Data Preprocessing and Normalization • Model Evaluation and Performance Metrics (Confusion Matrix, ROC, AUC, Precision, Recall, F1-score) • Cross-validation and Hyperparameter Tuning • Case Studies in Genomics and Proteomics	
Unit V	**Advanced Topics and Applications in Machine Learning for Bioinformatics** • Deep Learning Techniques (CNN, RNN, Autoencoders) • Biological Network Analysis and Pathway Prediction • Drug Discovery and Biomarker Identification • Integrative Multi-Omics Data Analysis • Ethical Issues and Interpretability in Machine Learning for Bioinformatics	**12**

Text Book & References :

Text:

Baldi, P., Brunak, S. — Bioinformatics: The Machine Learning Approach (MIT Press)

James, G., Witten, D., Hastie, T., Tibshirani, R. — An Introduction to Statistical Learning with Applications in R (Springer)

References:

Alpaydin, E. — Introduction to Machine Learning (MIT Press)

Raschka, S., Mirjalili, V. — Python Machine Learning (Packt Publishing)

Zou, J., Huss, M., Abid, A., Mohammadi, P., Torkamani, A., Telenti, A. — A Primer on Deep Learning in Genomics (Nature Genetics)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain key machine learning concepts, methods, and their relevance to bioinformatics.

CLO2: Apply supervised and unsupervised learning algorithms to solve biological problems.

CLO3: Perform dimensionality reduction and feature selection on complex biological datasets.

CLO4: Implement and evaluate machine learning models using Python or R for bioinformatics data analysis.

CLO5: Integrate machine learning tools for advanced bioinformatics applications like drug discovery, disease prediction, and multi-omics integration.

Program: Honors Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: IV** **Semester: VII**

Credits: 4 L 4 T 0 P 0	Subject: Major XIV
Course Code: BSBI-702	Title: Systems Biology

Course Objectives:

CO1: Understand the fundamental concepts, scope, and applications of systems biology in life sciences.

CO2: Analyze molecular interactions, networks, and the structure of biological systems using mathematical models.

CO3: Apply computational tools for modeling and simulating biological networks and cellular systems.

CO4: Integrate experimental data with computational models for functional analysis of biological pathways.

CO5: Evaluate the role of systems biology in drug discovery, personalized medicine, and disease modeling.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	**Introduction to Systems Biology** • Definition, scope, and importance of systems biology • Historical development and key concepts • Levels of biological organization: molecular, cellular, organismal, ecological • Principles of biological networks: Gene, protein, and metabolite networks • Applications of systems biology in health, agriculture, and environment	**12**
Unit II	**Modeling of Biological Networks** • Types of biological networks: gene regulatory, protein-protein interaction, metabolic networks • Mathematical modeling approaches: Boolean, deterministic, and stochastic models • Differential equation-based modeling for biological systems • Flux balance analysis in metabolic pathways • Model validation and parameter estimation	**12**
Unit III	**Computational Tools and Techniques in Systems Biology** • Computational tools for network construction and visualization (Cytoscape, Gephi) • Simulation software for dynamic modeling (COPASI, CellDesigner) • Algorithms for network analysis: centrality, modularity, clustering • Sensitivity analysis of biological networks • Data integration from omics platforms: genomics, transcriptomics, proteomics	**12**
Unit IV	**Pathway and Network Analysis** • Pathway databases: KEGG, Reactome, BioCyc • Gene regulatory networks and transcriptional control • Signal transduction networks: MAPK, PI3K-AKT pathways	**12**

	• Tools for pathway analysis and enrichment (DAVID, GSEA) • Case studies in metabolic and signaling pathway modeling	
Unit V	**Applications of Systems Biology in Disease and Drug Discovery** • Systems approaches in disease modeling (Cancer, Diabetes, Immune disorders) • Network pharmacology and drug target identification • Personalized medicine and biomarker discovery through systems biology • Multi-scale modeling of tissues and organs • Challenges and future directions in systems biology research	**12**

Text Book & References :

Text:

Alon, U. — An Introduction to Systems Biology: Design Principles of Biological Circuits (CRC Press)

Palsson, B.Ø. — Systems Biology: Constraint-based Reconstruction and Analysis (Cambridge University Press)

References:

Kitano, H. — Foundations of Systems Biology (MIT Press)

Klipp, E. et al. — Systems Biology: A Textbook (Wiley-VCH)

Voit, E.O. — A First Course in Systems Biology (Garland Science)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe systems biology concepts, approaches, and their significance in biological research.

CLO2: Develop and apply mathematical models to represent biological systems and networks.

CLO3: Utilize computational tools for simulation, analysis, and visualization of biological data and networks.

CLO4: Analyze complex biological pathways and integrate multi-omics data for network interpretation.

CLO5: Evaluate systems biology applications in disease modeling, drug development, and personalized medicine.

Program: Honors Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: IV** **Semester: VII**
Credits: 4 L 4 T 0 P 0	**Subject: Major XV**
Course Code: BSBI-704	Title: Genetic Engineering

Course Objectives:

CO1: Understand the history, scope, tools, and gene transfer techniques used in genetic engineering.

CO2: Explain restriction mapping, hybridization techniques, recombinant screening, and genetic engineering applications in animals.
CO3: Study genome editing methods, protein interaction assays, and protein engineering techniques.
CO4: Comprehend genetic engineering approaches in plants, gene therapy, and gene silencing technologies.
CO5: Analyze various gene manipulation strategies and develop insights into advanced genetic engineering applications.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Scope and History of Genetic Engineering Vectors: Nomenclature, Properties, Plasmids, Phage-based vectors (Phagemids, Cosmids), Yeast vectors, Artificial chromosomes, Plant & Animal vectors, Cassette vectors DNA Modifying Enzymes: Nucleases, Restriction Endonucleases, Phospho-monoesterase, Alkaline Phosphatase, Polynucleotide Kinase, DNA Ligase, DNA Polymerases, Reverse Transcriptase, Terminal Deoxynucleotidyl Transferase, Poly A Polymerase Gene Transfer Techniques: Physical Methods (Microinjection, Electroporation, Biolistics, Somatic Cell Fusion, Pronuclear Microinjection), Chemical Method (Liposomes), Virus-mediated Transfection	**12**
Unit II	Restriction and Modification Systems, Restriction Mapping Southern & Northern Hybridization Techniques Genomic and cDNA Libraries: Preparation, Comparison, Screening of Recombinants, Reverse Transcription Genome Mapping and DNA Fingerprinting Applications: Genetic Engineering in Animals, Transgenic Mice, ES Cells, Therapeutic Products (Blood Proteins, Hormones, Immune Modulators, Vaccines - One Example Each)	**12**
Unit III	Introduction to Genome Editing Techniques: Principles & Applications CRISPR-Cas9, Site-directed Mutagenesis, Other Genome Editing Tools DNA-Protein Interaction Studies: EMSA, DNase Footprinting, Methyl Interference Assay, ChIP Protein-Protein Interaction Studies: Yeast Two-Hybrid System, Phage Display Protein Engineering: Concepts, Examples (Any Two), Chimeric Proteins Production	**12**
Unit IV	Genetic Engineering in Plants: Agrobacterium tumefaciens & A. rhizogenes, Ti Plasmids Gene Transfer Strategies to Plant Cells, Direct DNA Transfer, Gene Targeting in Plants Use of Plant Viruses as Episomal Vectors Gene Therapy: Vector Engineering, Delivery Strategies, Gene	**12**

	Replacement, Correction, Editing, Regulation Knockout & Transgenic Technologies, Gene Silencing: Ribozymes, Antisense, RNAi Technologies	
Unit V	Applications in Agriculture, Medicine, and Industry Biosafety Concerns and Risk Assessment in Genetic Engineering Ethical, Legal, and Social Implications of Genetic Engineering Future Prospects and Emerging Trends in Genetic Engineering Case Studies on Recent Genetic Engineering Breakthroughs	**12**

Text Book & References :

Text:

Sambrook, J. & Russell, D.W. — Molecular Cloning: A Laboratory Manual (Cold Spring Harbor Laboratory Press)

Primrose, S.B. & Twyman, R.M. — Principles of Gene Manipulation and Genomics (Wiley-Blackwell)

References:

Watson, J.D., et al. — Recombinant DNA: Genes and Genomes – A Short Course (W.H. Freeman)

Glick, B.R. & Pasternak, J.J. — Molecular Biotechnology: Principles and Applications of Recombinant DNA (ASM Press)

Brown, T.A. — Gene Cloning and DNA Analysis: An Introduction (Wiley-Blackwell)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Demonstrate knowledge of genetic engineering tools, vectors, and gene transfer techniques.

CLO2: Perform analysis of recombinant DNA using hybridization, mapping, and library screening techniques.

CLO3: Apply genome editing and protein engineering methods for studying and manipulating genes and proteins.

CLO4: Evaluate plant genetic engineering methods, gene therapy strategies, and gene silencing technologies.

CLO5: Analyze genetic engineering applications, ethical aspects, and emerging biotechnological innovations.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: IV** **Semester: VII**
Credits: 4 L 3 T 0 P 0	**Subject: Minor IX**
Course Code: BSBI-705	Title: Entrepreneurship in Life Sciences
Course Objectives:	

CO1: Understand the fundamentals of entrepreneurship, innovation, and their significance in the life sciences sector.
CO2: Develop knowledge of startup development processes including idea generation, project formulation, and market analysis.
CO3: Analyze funding options, business models, intellectual property rights, and regulatory requirements for life science enterprises.
CO4: Apply managerial and operational strategies for scaling up biotech-based businesses.
CO5: Evaluate case studies of successful life science ventures and formulate business plans for life science-based products/services.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Concept and types of entrepreneurship Characteristics and skills of entrepreneurs Innovation in biotechnology and healthcare sectors Challenges and opportunities in life sciences entrepreneurship Role of entrepreneurship in economic development and job creation	**12**
Unit II	Business idea identification and opportunity evaluation Market research and analysis in life sciences Product development lifecycle in biotech & pharma industries Business Model Canvas for life sciences startups Regulatory and compliance factors in product development	**12**
Unit III	Funding sources: Government schemes, angel investors, venture capital, bank loans Financial planning, budgeting, and forecasting for life science startups Project cost estimation and break-even analysis Basics of accounting and tax considerations for biotech businesses Intellectual Property Rights (IPR) in life sciences: Patents, licensing, and technology transfer	**12**
Unit IV	Operational planning and supply chain management in biotech startups Human resource management and team building for startups Sales and marketing strategies in life sciences Branding and digital marketing for biotech businesses Risk assessment and contingency planning	**12**
Unit V	Case studies of successful biotech, pharma, and healthcare startups Writing a business plan: Executive summary, market analysis, product/service description, financial projections Pitching and fundraising strategies Business ethics and corporate social responsibility (CSR) in life sciences Legal, regulatory, and global trends impacting life sciences entrepreneurship	**12**

Text Book & References :
Text:
Vasant Desai — Dynamics of Entrepreneurial Development and Management (Himalaya

Publishing)
Kuratko, D.F. & Hodgetts, R.M. — Entrepreneurship: Theory, Process and Practice (Cengage Learning)

References:
Nicholas S. Vonortas et al. — Entrepreneurship, Technology Commercialization and Innovation Policy in the USA (Edward Elgar Publishing)
Sahlman, W.A., Stevenson, H.H., Roberts, M.J., & Bhidé, A. — Entrepreneurial Venture (Harvard Business School Press)
Handbook of Biotechnology Entrepreneurship — Edited by Craig Shimasaki (Academic Press)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:
CLO1: Explain the principles of entrepreneurship and recognize business opportunities in the life sciences sector.
CLO2: Analyze startup processes including market research, product development, and regulatory compliance.
CLO3: Apply funding strategies, financial planning, and intellectual property tools in life science enterprises.
CLO4: Demonstrate operational planning, marketing, and risk management strategies for sustainable life science businesses.
CLO5: Develop business plans and assess real-world biotech ventures for entrepreneurship readiness.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: IV** **Semester: VII**
Credits: 2 L 0 T 0 P 4	**Subject: Practical VII (based on Major XIII + XIV)**
Course Code: BSBI-703P	Title: Machine Learning and System Biology Lab

Course Objectives:

CO1: Understand the fundamental concepts, principles, and applications of systems biology in biological sciences.

CO2: Explore various computational tools and mathematical modeling approaches for biological networks and pathways.

CO3: Gain knowledge of machine learning fundamentals, including supervised and unsupervised learning algorithms used in bioinformatics.

CO4: Develop practical skills in using machine learning tools and programming languages (Python/R) for biological data analysis and visualization.

CO5: Evaluate advanced applications of systems biology and machine learning in disease modeling, drug discovery, and integrative multi-omics analysis.

Nature of Paper: Core Course Practical

Minimum Passing Marks/Credits: 40%

List of Practical

1. Construct and visualize gene regulatory networks using Cytoscape or Gephi from a sample dataset.
2. Perform dynamic simulation of a metabolic pathway using COPASI or CellDesigner.
3. Conduct pathway enrichment analysis using DAVID or GSEA for a gene list from transcriptomics data.
4. Analyze signal transduction pathways using KEGG and Reactome databases with real biological data.
5. Build and interpret Boolean or differential equation-based models for a biological process (e.g., MAPK pathway).
6. Implement supervised learning algorithms (SVM, Random Forest) for disease classification using gene expression data (Python/R).
7. Perform clustering analysis (K-means, hierarchical clustering) on gene expression datasets to identify co-expressed genes.
8. Apply dimensionality reduction techniques (PCA, t-SNE) to visualize high-dimensional omics data.
9. Develop and evaluate a machine learning model using scikit-learn or TensorFlow for protein function prediction.
10. Integrate multi-omics datasets and perform predictive modeling for biomarker discovery using advanced machine learning tools.

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Describe key concepts of systems biology and its significance in biological network analysis and modeling.
CLO2: Apply computational tools for constructing, simulating, and analyzing biological networks and pathways.
CLO3: Implement supervised and unsupervised machine learning algorithms for analyzing biological datasets.
CLO4: Demonstrate proficiency in programming (Python/R) for machine learning-based analysis of genomic and proteomic data.
CLO5: Integrate systems biology and machine learning approaches for solving complex biological problems such as disease modeling and drug discovery.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: IV** **Semester: VII**
Credits: 2 L 0 T 0 P 4	**Subject: Practical VIII (based on Major XV)**
Course Code: BSBI-706P	Title: Genetic Engineering Lab

Course Objectives:
CO1: Understand the fundamental principles, history, and applications of genetic engineering and recombinant DNA technology.
CO2: Apply DNA isolation, purification, and analysis techniques such as restriction digestion, electrophoresis, and hybridization.
CO3: Perform gene cloning and gene transfer techniques using various biological vectors and transformation methods.
CO4: Explore advanced molecular biology tools for genome editing, DNA-protein interaction, and protein engineering studies.
CO5: Analyze and assess ethical, biosafety, and regulatory considerations in genetic engineering research and applications.

Nature of Paper: Core Course Practical

Minimum Passing Marks/Credits: 40%

List of Practical

1. Isolation and Purification of Genomic DNA from Bacteria or Plant Tissues.
2. Restriction Digestion of DNA Using Restriction Endonucleases and Analysis by Agarose Gel Electrophoresis.
3. Ligation of DNA Fragments and Construction of Recombinant Plasmids Using DNA Ligase.
4. Preparation and Screening of Competent Cells for Transformation Using Plasmid Vectors (e.g., pUC19, pBR322).
5. Gene Transfer into Bacteria Using Heat Shock and Electroporation Methods.
6. Southern Blotting Technique for Detection of Specific DNA Sequences.
7. PCR Amplification of Target DNA and Reverse Transcription PCR (RT-PCR) for cDNA Synthesis.
8. CRISPR-Cas9 Mediated Gene Editing Demonstration Using Plasmid Systems (Simulation/Virtual or Wet Lab Demonstration).
9. Electrophoretic Mobility Shift Assay (EMSA) for DNA-Protein Interaction Analysis.
10. Case Study-Based Report on Biosafety Guidelines and Ethical Issues in Genetic Engineering Projects (Presentation/Assignment).

Evaluation/Assessment Methodology

Max. Marks

1) Attendance 2) Quiz / PPT / Assignments 3) Mid Sem Test 4) End Sem Exam	5 10 15 70
Total:	100

Course Learning Outcomes:

CLO1: Demonstrate practical knowledge of DNA manipulation and analysis techniques, including restriction digestion and mapping.

CLO2: Construct and screen recombinant DNA molecules using cloning vectors and host systems.

CLO3: Perform gene transfer experiments using physical, chemical, and biological methods in bacterial and plant systems.

CLO4: Apply genome editing techniques and study DNA-protein or protein-protein interactions using advanced molecular tools.

CLO5: Evaluate case studies and explain biosafety, ethical, and social issues related to genetic engineering technologies.

SYLLABUS (SEMESTER: VIII)

Program: Honors Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: IV** **Semester: VIII**
Credits: 4 L 4 T 0 P 0	**Subject: Major XVI**
Course Code: BSBI-801	Title: Research methodology in Bioinformatics

Course Objectives:

CO1: Understand fundamental concepts of scientific research and its methodology in bioinformatics.

CO2: Develop knowledge of experimental design, data collection, and sampling methods in computational biology.

CO3: Apply tools and techniques for literature review, scientific writing, and research ethics.

CO4: Demonstrate ability to formulate research problems and hypotheses in bioinformatics projects.

CO5: Integrate statistical, computational, and bioinformatics approaches to solve research problems and present findings effectively.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Definition, Objectives, and Significance of Research Types of Research: Fundamental, Applied, and Translational Scientific Methods and Steps in Research Process Research Approaches in Bioinformatics: Computational, Experimental, and Theoretical Formulating Research Questions and Objectives	**12**
Unit II	Sources of Scientific Literature: Journals, Books, Databases, Patents Literature Search Tools: PubMed, Scopus, Google Scholar, Web of	**12**

	Science Referencing and Citation Styles (APA, MLA, Vancouver, etc.) Plagiarism and Research Misconduct Ethical Practices in Bioinformatics Research	
Unit III	Research Design: Experimental, Descriptive, and Exploratory Designs Population and Sampling: Sampling Methods (Random, Stratified, Cluster) Sample Size Determination Data Collection Techniques: Surveys, Experiments, Simulations, Mining Databases Questionnaire Design and Validation	**12**
Unit IV	Overview of Data Analysis Approaches in Bioinformatics Introduction to Bioinformatics Tools for Data Retrieval and Analysis Statistical Tools for Bioinformatics Research Introduction to Data Mining Techniques in Biological Research Use of Open-Source Tools (R, Python, Bioconductor) in Research	**12**
Unit V	Writing Scientific Research Papers, Review Articles, and Project Reports Structure of a Scientific Manuscript: Title, Abstract, Introduction, Methods, Results, Discussion, References Preparing Thesis and Dissertations Conference Presentations and Poster Preparation	**12**

Text Book & References :

Text:

Gopal, M.H. — Research Methodology and Biostatistics (Jaypee Brothers Medical Publishers)

Krishnaswami, O.R. & Ranganathan, M. — Methodology of Research in Social Sciences (Himalaya Publishing House)

References:

Kothari, C.R. — Research Methodology: Methods and Techniques (New Age International Publishers)

Day, R.A. & Gastel, B. — How to Write and Publish a Scientific Paper (Cambridge University Press)

Prajapati, R. & Bhavsar, V. — Research Methodology for Life Science (Kalyani Publishers)

Evaluation/Assessment Methodology	
Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Define research methodology, types of research, and apply appropriate methods in bioinformatics studies.

CLO2: Perform literature reviews and follow ethical principles in bioinformatics research.

CLO3: Design bioinformatics experiments using appropriate sampling and data collection methods. **CLO4:** Utilize computational tools and statistical methods for data analysis in bioinformatics research. **CLO5:** Prepare scientific research papers, project reports, and effectively communicate research findings in bioinformatics.

Program: Degree – Bioinformatics **Class: B.Sc Bioinformatics**	**Year: IV** **Semester: VIII**
Credits: 4 L 3 T 0 P 0	**Subject: Minor X**
Course Code: BSBI-802	Title: Literature review and Scientific writing

Course Objectives:

CO1: Understand the purpose, types, and process of literature review in scientific research.
CO2: Acquire skills in searching, retrieving, and critically analyzing scientific literature using databases and tools.
CO3: Develop competence in organizing scientific information, paraphrasing, and avoiding plagiarism.
CO4: Learn principles of scientific writing for different formats including articles, reports, and reviews.
CO5: Apply referencing styles, citation methods, and ethical standards in scientific communication.

Nature of Paper: Core Course Theory

Minimum Passing Marks/Credits: 40%

Unit	Content	Lecture
Unit I	Purpose and significance of literature review Types of literature review: Narrative, Systematic, Meta-analysis, Scoping reviews Steps in conducting literature review Identifying research gaps and framing research questions Importance of literature review in research proposal development	**12**
Unit II	Types of scientific publications: Primary, Secondary, and Tertiary Scientific databases: PubMed, Scopus, Web of Science, Google Scholar Search strategies: Keywords, Boolean operators, Filters Use of Reference Management Tools (Mendeley, Zotero, EndNote) Critical appraisal of research articles (using checklists or frameworks)	**12**
Unit III	Structure of scientific articles: IMRAD format (Introduction, Methods, Results, Discussion) Abstract writing and graphical abstract basics Paraphrasing, Summarizing, and Synthesizing literature Avoiding plagiarism: Tools and Techniques (Turnitin, iThenticate) Writing style: Clarity, Conciseness, Consistency, and Coherence	**12**
Unit IV	Components of a Technical Report: Title page, Executive summary,	**12**

	Introduction, Body, Conclusion Writing Research Proposals: Background, Objectives, Methodology, Expected outcomes, Budget Scientific Presentations: Oral, Poster, and Digital Presentations Common mistakes in scientific writing and how to avoid them Peer Review Process: Submission, Review, and Revision stages	
Unit V	Citation Styles: APA, MLA, Vancouver, Harvard, and Chicago In-text citations and Reference list preparation Ethical standards in scientific publishing: Authorship, Conflicts of Interest, Data Integrity Copyrights, Licensing, and Open Access Publishing Case Studies on Ethical Issues in Scientific Writing	**12**

Text Book & References :

Text:

Day, R.A. & Gastel, B. — How to Write and Publish a Scientific Paper (Cambridge University Press)

Hofmann, A.H. — Scientific Writing and Communication: Papers, Proposals, and Presentations (Oxford University Press)

References:

Glasman-Deal, H. — Science Research Writing for Non-Native Speakers of English (World Scientific)

Lang, T.A. & Secic, M. — How to Report Statistics in Medicine (American College of Physicians)

Peat, J., Elliott, E., Baur, L., & Keena, V. — Scientific Writing: Easy When You Know How (BMJ Books)

Evaluation/Assessment Methodology

Max. Marks	
1) Attendance	5
2) Quiz / PPT / Assignments	10
3) Mid Sem Test	15
4) End Sem Exam	70
Total:	100

Course Learning Outcomes:

CLO1: Explain the process and purpose of literature review in scientific research.
CLO2: Search, retrieve, and critically appraise scientific literature from reliable sources.
CLO3: Write scientifically organized documents with proper paraphrasing and originality.
CLO4: Prepare technical reports, research proposals, and scientific presentations effectively.
CLO5: Apply correct citation, referencing styles, and ethical practices in scientific writing and publishing.