SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. (Bioinformatics) semester II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2T02NCBIF01**	Genetic Engineering	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Understand principles and tools of genetic engineering including enzymes and cloning techniques.

CLO2: Apply knowledge of vectors and host systems for gene cloning and expression.

CLO3: Analyse PCR techniques, sequencing methods, and mutation detection approaches.

CLO4: Apply genetic engineering techniques in diagnostics, research, and biotechnology applications.

CLO5: Evaluate applications of genetic engineering in medicine, agriculture, and gene therapy with biosafety considerations.

CLO6: Interpret ethical, regulatory, and IKS perspectives in modern genetic engineering**.**

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Introduction and Tools for Genetic Engineering: Impact of genetic engineering in modern society. General requirements for performing a genetic engineering experiment – restriction endonucleases and methylases, DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase. Cohesive and blunt end ligation, linkers, adaptors, homopolymer tailing. Labelling of DNA - nick translation, random priming, radioactive and non-radioactive probes. Construction of libraries; Introduction of DNA into host cells; screening and selection methods for recombinant clones. Hybridization techniques - northern, southern, south-western, far-western, colony hybridization, and fluorescence in situ hybridization.	Classroom Lecture (CL), ICT-Enabled Learning, Self-Directed Learning, Inquiry-Based Learning	CLO1
II	Different Types of Vectors: Plasmids, Bacteriophages, M13mp vectors, pUC19 and pBluescript vectors, phagemids, Lambda vectors, Insertion and Replacement vectors, Cosmids, Artificial chromosome vectors (YACs and BACs). pMal, GST, pET-based vectors. Intein-based vectors. Mammalian expression and replicating vectors, Baculovirus and *pichia* vectors system, plant-based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors. Salient features of expression vectors for heterologous expression in E. coli, Yeast, Insect and Mammalian system, factors influencing heterologous gene expression, Principles for maximizing gene expression in vectors. Protein purification - His-tag, GST-tag, MBP-tag *etc.* Introduction to CRISPER/Cas9 plasmids.	Classroom Lecture (CL), ICT-Enabled Learning, Guided Learning, Self-Directed Learning	CLO2

III	Different Types of PCR Techniques and Sequencing: Principles of PCR, primer design, fidelity of thermostable enzymes, DNA polymerases. Types of PCR - multiplex, nested, real time PCR, touchdown PCR, hot start PCR, colony PCR. Cloning of PCR products, T – vectors. Proof reading enzymes. PCR based site specific mutagenesis. PCR in molecular diagnostics, viral and bacterial detection. Chemical synthesis of oligonucleotides. Mutation detection - SSCP, DGGE, RFLP. Sequencing methods - enzymatic DNA sequencing, chemical sequencing of DNA, automated DNA sequencing, RNA sequencing.	Classroom Lecture (CL), ICT-Enabled Learning, Inquiry-Based Learning,	CLO3, CLO4
IV	Applications of Genetic engineering:Applications of Genetic engineering in improvement of plants, animals and microbes; Gene editing and its applications; Metagenomics and Metabolic engineering; Human disorders and Gene therapy; Gene therapy; Restriction and regulations for the release of GMOs; Biosafety and levels of Physical and Biological containment; The Indian Guidelines for release and use of GM organisms. **Overview of Ancient Indian Scriptures with Biotechnological Relevance Genetic engineering analogies in Mahabharata, Bioethics and cloning perspectives from Scriptures Integration of IKS with Modern Scientific and Biotechnological Paradigms: Biopiracy, patents, and traditional knowledge validation, Bioethical reflections from epics in modern biotech debates.**	Classroom Lecture (CL), ICT-Enabled Learning, Reflective Practices	CLO5, CLO6

- **(*) Learning Pedagogies/Methods**

  Notes:
  (1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.
  (2) Acronyms/abbreviations of the terms can be placed in the above table.
  (a) Interactive Classroom Lecture
  (b) Classroom Lecture (CL)
  (c) Seminars (Student-led and Faculty-moderated)
  (d) Micro-Projects/Mini Research Tasks
  (e) Industrial Visit/Field Visit/Institutional Visit
  (f) Problem-Based Learning (PBL)
  (g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
  (h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
  (i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
  (j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
  (k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
  (l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(A)Internal Assessment

a. Internal Formative assessment (30)

(a) Quiz
(b) Assignment
(c) Seminar/Presentation
(d) Group Task
(e) Attendance

b. Internal Summative Assessment (20)

(a) Mid -Term

(B)External Assessment (50)

(b) End-Term

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1	30	1	1	12	14
II	CLO2	32	1	1	10	12
III	CLO3, CLO4	28	1	1	10	12
IV	CLO5, CLO6	30	1	1	12	14
		120	**04**	**04**	**34**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50%
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50%

- **CLOs – PLOs Matrix**

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	-	-	-	-	-	-	-	-
CLO2	2	3	2	-	-	-	-	-	-	-
CLO3	-	2	3	2	-	-	-	-	-	-
CLO4	-	-	2	3	2	-	-	-	-	-
CLO5	-	-	-	2	3	2	-	-	1	-
CLO6	-	-	-	-	2	3	2	2	2	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Molecular Biotechnology: Principles and Applications	Bernard R. Glick et al.	5th Ed., 2010	ASM Press
2	Principles of Gene Manipulation and Genomics	Sandy B. Primrose & Richard Twyman	7th Ed., 2006	Blackwell
3	Gene Cloning and DNA Analysis	T.A. Brown	7th Ed., 2016	Wiley
4.	Molecular Biology of the Gene	James D. Watson et al.	7th Ed., 2013	Pearson
5	Recombinant DNA Technology	Watson et al.	3rd Ed., 2007	Freeman
6	Introduction to Genetic Engineering	A.J. Nair	2nd Ed., 2011	Jones & Bartlett
7	Biotechnology	U. Satyanarayana	1st Ed., 2008	Books & Allied
8	Bioethics in Biotechnology	V. Sreekrishna	2010	Academic Press

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Genetic Engineering & Biotechnology Tutorials	https://www.ncbi.nlm.nih.gov
2	Molecular Biology & Cloning Techniques	https://www.addgene.org
3	PCR & Sequencing Learning Resources	https://www.khanacademy.org/science
4	Bioinformatics & Genomics Tools	https://www.ebi.ac.uk

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. (Bioinformatics) semester II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2T02NCBIF02**	Mathematics and Biostatistics	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Apply matrix operations and solve systems of linear equations using determinants and Cramer's rule.

CLO2: Understand vector spaces, linear independence, basis, eigenvalues, and eigenvectors.

CLO3: Apply concepts of limits, continuity, differentiation, and integration to solve problems.

CLO4: Use numerical methods (Bisection, Regula-Falsi, Newton-Raphson) for solving equations.

CLO5: Analyze and interpret data using statistical measures such as mean, median, standard deviation, correlation, and regression.

CLO6: Apply probability concepts, distributions, and hypothesis testing techniques in data analysis.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	**Ancient Indian Mathematics: Number Systems: Bhuta-Saṃkhya, Kaṭapayadi; historical context and significance. Measurement Systems: Time, distance, and weight in ancient India. Pingala's Binary System: Origin from Chandaḥsastra and its influence on metrics and binary logic.** Matrices: - Properties of Determinants, Minors and Cofactors, Multiplication of Determinants, Adjoint, Reciprocal, Symmetric Determinants, Cramer's rule, Different types of matrices, Matrix Operations, Transpose of a matrix, Adjoint of a square matrix, Inverse of a matrix	Lecture-based learning, Problem-based learning, ICT-enabled learning,	CLO1, CLO2
II	Calculus: differential calculus: Derivative of a function, Concept of limit, Continuity, Differentiation, Maxima and Minima of a function, Introduction to Partial Differentiation, Integral Calculus: The Idea of the Integral, The Definite Integrals, Indefinite Integrals. Numerical Methods: Solution of algebraic and transcendental equations: Bisection method, Method of false position / Regula-falsi method, Newton-Raphson method.	Lecture method, Problem-based learning, ICT-enabled learning	CLO3, CLO4
III	Numerical Descriptive Techniques: Measures of central tendency: mean, median, mode, relation between mean, median and mode. Partition values: quartiles, deciles, percentiles; Measures of dispersion: Absolute and Relative Measures, Moments, skewness and kurtosis Correlation and Regression: Principles of least squares, scatter diagram,	ICT-enabled learning,	CLO5

	correlation, covariance, correlation coefficient, properties of correlation coefficient, regression, properties of linear regression, rank correlation, multiple correlation		
IV	Probability Theory: Concept of probability: sample space and events, independent events, mutually exclusive events. axioms of probability, conditional probability, Baye's theorem, Introduction to Markov Chain Model. Sampling Distribution of Sample Mean and Sample Proportion, Standard Error Probability Distribution: Bernoulli trials, binomial distribution, normal distributions, Poisson distribution, Test of Hypothesis of Small and Large Samples- Standard Normal distribution, Chi-square distribution, Student's t distribution, F distribution, Analysis of Variance	ICT-enabled learning,	CLO6

- **(*) Learning Pedagogies/Methods**

Notes:
(1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.
(2) Acronyms/abbreviations of the terms can be placed in the above table.

(a) Interactive Classroom Lecture
(b) Classroom Lecture (CL)
(c) Seminars (Student-led and Faculty-moderated)
(d) Micro-Projects/Mini Research Tasks
(e) Industrial Visit/Field Visit/Institutional Visit
(f) Problem-Based Learning (PBL)
(g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
(h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
(i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
(j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
(k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
(l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(A)Internal Assessment

c. Internal Formative assessment (30)

(a) Quiz
(b) Assignment
(c) Seminar/Presentation
(d) Group Task
(e) Attendance

d. Internal Summative Assessment (20)

(a) Mid -Term

(B)External Assessment (50)

(b) End-Term

(B)Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2	30	1	1	12	14
II	CLO3, CLO4	32	1	1	10	12
III	CLO5	28	1	1	10	12
IV	CLO6	30	1	1	12	14
		120	**04**	**04**	**34**	**50**

- Assessment and Evaluation

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	**50%**
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	**50%**

- **CLOs – PLOs Matrix**

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	-	-	-	-	-	-	2	-
CLO2	2	3	2	-	-	-	-	-	3	-
CLO3	-	2	3	2	-	-	-	-	2	1
CLO4	-	-	2	3	2	-	-	-	3	2
CLO5	-	-	-	2	3	2	-	-	2	3
CLO6	-	-	-	-	2	3	2	2	-	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Instrumental Methods of Analysis	Douglas A. Skoog, F. James Holler, Stanley R. Crouch	6th Edition / 2007	Cengage Learning
2	Instrumentation	H. K. Chatwal, S. K. Anand	5th Edition / 2009	Himalaya Publishing House
3	Biomedical Instrumentation and Measurements	Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer	2nd Edition / 1980	Prentice Hall
4	Modern Experimental Biochemistry	Rodney F. Boyer	3rd Edition / 2000	Benjamin Cummings
5	An Introduction to Practical Biochemistry	David T. Plummer	3rd Edition / 1987	McGraw-Hill

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Khan Academy (Math & Statistics)	https://www.khanacademy.org
2	MIT OpenCourseWare (Linear Algebra, Calculus)	https://ocw.mit.edu
3	NPTEL (Indian Courses)	https://nptel.ac.in
4	Coursera (Free Courses - Audit Mode)	https://www.coursera.org

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NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. (Bioinformatics) semester II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2T02NCBIF03**	Web Application Development in Bioinformatics	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Understand basic concepts of computer networks, communication technologies, network types, and topology.

CLO2: Explain networking hardware, protocols, internet services, and functions of network devices.

CLO3: Understand XML fundamentals and differentiate XML from HTML, XHTML, and SGML.

CLO4: Create well-formed and valid XML documents using elements, attributes, and namespaces.

CLO5: Develop web applications using Java Servlets and understand their life cycle and architecture.

CLO6: Design dynamic web pages using JSP, including directives, scripting elements, and implicit objects, with applications in bioinformatics.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	NETWORK BASICS: Communication Technology – Networking Elements: Networking Hardware, advantages of computer networking, Introduction to the concept of protocol, Network topology, Networking services: Types of Networks – LANs, WANs & MANs, Intranet–Wireless communication – Internet services, Uses of Internet, Function of network connecting devices.	Lecture-based learning, ICT-enabled learning,	CLO1, CLO2
II	XML: Comparison of XML with HTML, XHTML, SGML, RSS, MathML, WAP; XML syntax/elements/attributes; Fundamentals of XML; Write simple XML files; Viewing XML in browser; Creating Well-Formed XML Documents; Creating Valid XML Documents; Fundamentals of XML Namespaces.	Lecture method, ICT-enabled learning	CLO3, CLO4
III	JAVA SERVLETS AND JAVA SEVER PAGES (JSP) – I: Introduction to Java servlets, The servlet life cycle, using generic servlets and HTTP servlets, Introduction to Java Server Pages, JSP Architecture and life cycle, developing simple JSP pages, Introduction to security in servlets/JSP enIVronment Case studies related to bioinformatics	ICT-enabled learning	CLO5
IV	JAVA SERVLETS AND JAVA SEVER PAGES (JSP) - II: JSP directives, JSP scripting elements, JSP action elements, JSP implicit objects, Introduction to internationalization Case studies related to bioinformatics	ICT-enabled learning	CLO6

- **(*) Learning Pedagogies/Methods**

  Notes:
  (1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.
  (2) Acronyms/abbreviations of the terms can be placed in the above table.

  (a) Interactive Classroom Lecture
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  (f) Problem-Based Learning (PBL)
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  (h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
  (i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
  (j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
  (k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
  (l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(A)Internal Assessment

a. Internal Formative assessment (30)

(a) Quiz
(b) Assignment
(c) Seminar/Presentation
(d) Group Task
(e) Attendance

b. Internal Summative Assessment (20)

(a) Mid –Term
(b)

(B)External Assessment (50)

(c) End-Term
(d)

(B)Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2	30	1	1	12	14
II	CLO3, CLO4	32	1	1	10	12
III	CLO5	28	1	1	10	12
IV	CLO6	30	1	1	12	14
		120	**04**	**04**	**34**	**50**

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NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. (Bioinformatics) semester II

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	**50%**
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	**50%**

- **CLOs – PLOs Matrix**

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	-	-	-	-	-	-	2	-
CLO2	2	3	2	-	-	-	-	-	3	-
CLO3	-	2	3	2	-	-	-	-	2	1
CLO4	-	-	2	3	2	-	-	-	3	2
CLO5	-	-	-	2	3	2	-	-	2	3
CLO6	-	-	-	-	2	3	2	2	-	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Computer Networking: A Top-Down Approach	James F. Kurose, Keith W. Ross	7th Edition / 2016	Pearson
2	Data Communications and Networking	Behrouz A. Forouzan	5th Edition / 2013	McGraw-Hill
3	XML: The Complete Reference	Darcy DiNucci, Cliff Dyson, John Paul Mueller	1st Edition / 2002	McGraw-Hill
4	Java Servlet Programming	Jason Hunter, William Crawford	2nd Edition / 2001	O'Reilly Media
5	Head First Servlets and JSP	Bryan Basham, Kathy Sierra, Bert Bates	2nd Edition / 2008	O'Reilly Media

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL – Free courses on Computer Networks, XML, and Web Technologies	https://nptel.ac.in
2	W3Schools – Tutorials for XML, JSP, Servlets, and Web Development	https://www.w3schools.com
3	Oracle Documentation – Official Java, Servlet, and JSP guides	https://docs.oracle.com
4	MDN Web Docs – Comprehensive web development and internet technology reference	https://developer.mozilla.org

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NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. (Bioinformatics) semester II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2T02NCBIF04**	Practical's based on Genetic Engineering and Mathematics and Biostatistics	0-8-0	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Perform basic genetic engineering techniques such as plasmid isolation, restriction digestion, and bacterial transformation.

CLO2: Apply molecular biology tools like PCR, qPCR, and electrophoresis for gene and protein analysis.

CLO3: Analyze biological sequences using bioinformatics tools such as BLAST and NCBI databases.

CLO4: Demonstrate understanding of biosafety guidelines and ethical considerations in genetic engineering.

CLO5: Use R programming for data handling, visualization, and statistical analysis.

CLO6: Apply statistical methods (t-test, ANOVA, regression, PCA) to interpret biological data.

Practical Content	Learning Pedagogies*	CLO(s)
1. Isolation of plasmid DNA and its quantification 2. Restriction digestion of plasmid DNA using restriction enzymes 3. Preparation of competent E. coli cells ($CaCl_2$ method) 4. Transformation of bacteria with plasmid DNA 5. Blue-white screening using pUC19 vector system/Selection of recombinants using antibiotic resistance markers 6. Protein extraction from bacterial cells 7. SDS-PAGE for protein analysis 8. Primer design for PCR (bioinformatics-based) 9. Basic PCR amplification of a gene 10. Real-Time PCR (qPCR demo) 11. PCR product purification 12. DNA sequence analysis using software tools 13. Sequence alignment using bioinformatics tools (BLAST) 14. Study of Indian biosafety guidelines (documentation practical) 15. Gene sequence retrieval from NCBI database 16. Case study: "Sanjeevani Booti" and herbal pharmacology (literature analysis) Basic R: 1. Obtaining R 2. Generating R codes,	Demonstration-based, Laboratory Teaching, Hands-on Practical / Experimental Learning, Bioinformatics-based Learning, Case Study, Problem-solving, Data Analysis, Application-based Learning	CLO1 to CLO6

3. Scripts, 4. Text editors for R, 5. Graphical User Interfaces (GUIs) for R, 6. Introduction of Packages R Objects and data structures: R Objects and data structures: 7.Variable classes, 8. Vectors and matrices, 9. Data frames and lists, 10. Data sets included in R packages, 11. Summarizing and exploring data Manipulating objects in R: 12. Mathematical operations (recycling rules, propagation of names, dimensional attributes, NA handling) 13. Basic matrix computation (element-wise multiplication, 14. matrix multiplication, outer product, 15. transpose, eigenvalues, eigenvectors), 16. Textual operations 17. Basic graphics Hypothesis testing and data handling: 18. Parametric and nonparametric tests, 19. Chi-square test, 20. t-tests, ANOVA, 21. Correlation and regression, 22. Principal component Analysis		

- **(*) Learning Pedagogies/Methods**

  Notes:

  (1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

  (2) Acronyms/abbreviations of the terms can be placed in the above table.

  (a) Interactive Classroom Lecture
  (a) Classroom Lecture (CL)
  (b) Seminars (Student-led and Faculty-moderated)
  (c) Micro-Projects/Mini Research Tasks
  (d) Industrial Visit/Field Visit/Institutional Visit
  (e) Problem-Based Learning (PBL)
  (f) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
  (g) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
  (h) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
  (i) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
  (j) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
  (k) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(A) Internal Assessment

(a) Internal Formative assessment (30)

(a) Journal Evaluation
(e) Method of Working
(f) Attendance

(b) Internal Summative Assessment (20)

(g) Mid -Term
(h) Viva-Voce

(B) Weightage of Learning Efforts for External Assessment

Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
		Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
CO1-CO6	**120**	**05**	10	**35**	**50**
	120	**05**	10	**35**	**50**

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	3	2	-	-	-	-	-	-
CLO2	3	3	2	2	-	-	-	-	-	-
CLO3	2	3	3	2	2	-	-	-	-	-
CLO4	2	2	2	3	3	-	-	-	-	-
CLO5	-	2	2	3	3	2	-	-	-	-
CLO6	-	2	3	3	2	2	-	-	-	-

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Molecular Cloning: A Laboratory Manual	Sambrook & Russell	Latest	Cold Spring Harbor
2	Principles of Gene Manipulation	Old & Primrose	Latest	Wiley
3	Introduction to Bioinformatics	Arthur Lesk	Latest	Oxford
4.	Bioinformatics: Sequence and Genome Analysis	David W. Mount	Latest	CSHL Press
5	R for Data Science	Hadley Wickham & Garrett Grolemund	Latest	O'Reilly
6	Biostatistics: A Foundation for Analysis	Wayne Daniel	Latest	Wiley
7	Practical Statistics for Data Scientists	Bruce & Bruce	Latest	O'Reilly
8	Fundamentals of Molecular Biology	Turner et al.	Latest	Wiley

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NCBI Database	https://www.ncbi.nlm.nih.gov
2	BLAST Tool	https://blast.ncbi.nlm.nih.gov
3	R Project	https://cran.r-project.org
4	Bioconductor	https://www.bioconductor.org

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. (Bioinformatics) semester II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2T02NCBIF05**	Practical's based on Web Application in Bioinformatics and Databases in Bioinformatics	0-8-0	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Understand the fundamentals of web applications, including Servlet architecture, JSP environment, and HTTP protocol.

CLO2: Explain JSP syntax, scripting elements, directives, and standard actions used for developing dynamic web pages.

CLO3: Apply XML concepts to create, view, and structure data using well-formed XML documents.

CLO4: Implement database design using Data Definition Language (DDL) commands such as creating, modifying, and deleting databases and tables.

CLO5: Analyze and perform Data Manipulation Language (DML) operations including inserting, updating, deleting, and retrieving data using SQL queries.

CLO6: Evaluate advanced SQL operations such as joins, subqueries, indexing, grouping, and database security mechanisms like granting and revoking privileges.

Practical Content	Learning Pedagogies*	CLO(s)
1. Setting Up a Servlet and JSP Environment 2. Two Types of Syntax 3. Scripting Elements 4. JSP Configuration 5. Standard JSP Actions 6. Web Application 7. Servlets and HTTP Servlets 8. GET and POST 9. HTTP Response Codes 10. JSP in XML Syntax XML 11. Write an XML code to IVew a simple XML file 12. Write an XML file for storing a database. 13. Data Definition Language (DDL) statements: Creating database, Selecting database, deleting database, creating table, Modifying Table, 14.Deleting table Data Manipulation statements: a) Inserting, updating and deleting records b) Retrieving Records c) Retrieving specific rows and columns d) Use of MySQL operators – Arithmetic operators, Comparison e) Operators, Logical operators f) Math functions, Aggregate functions	Demonstration-based, Laboratory Teaching, Hands-on Practical / Experimental Learning, Problem-solving, Application-based Learning	CLO1 to CLO6

g) String operations h) Limiting, Sorting and grouping query results i) Handling null values j) Renaming or aliasing table and column names k) Using subqueries l) Using Joins – joining a table to itself, joining multiple tables m) Use of Indexes n) Security Management o) Granting and Revoking rights on tables		

- **(*) Learning Pedagogies/Methods**

  Notes:

  (1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

  (2) Acronyms/abbreviations of the terms can be placed in the above table.

  (a) Interactive Classroom Lecture
  (b) Classroom Lecture (CL)
  (c) Seminars (Student-led and Faculty-moderated)
  (d) Micro-Projects/Mini Research Tasks
  (e) Industrial Visit/Field Visit/Institutional Visit
  (f) Problem-Based Learning (PBL)
  (g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
  (h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
  (i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
  (j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
  (k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
  (l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

  (A)Internal Assessment

  a. Internal Formative assessment (30)

  (a) Journal Evaluation
  (b) Method of Working
  (c) Attendance

  b. Internal Summative Assessment (20)

  (a) Mid -Term
  (b) Viva-Voce

(B) Weightage of Learning Efforts for External Assessment

Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
		Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
CO1-CO6	**120**	**05**	10	**35**	**50**
	120	**05**	10	**35**	**50**

- **CLOs – PLOs Matrix**

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	2	2	-	-	-	-	-	-
CLO2	3	3	2	2	-	-	-	-	-	-
CLO3	2	2	3	2	2	-	-	-	-	-
CLO4	2	3	3	2	2	-	-	-	-	-
CLO5	2	2	3	3	2	2	-	-	-	-
CLO6	2	2	3	3	3	2	-	-	-	-

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Java Servlet and JSP Cookbook	Bruce W. Perry	Latest	O'Reilly
2	Head First Servlets and JSP	Bryan Basham et al.	Latest	O'Reilly
3	Learning XML	Erik T. Ray	Latest	O'Reilly
4.	Database System Concepts	Silberschatz, Korth	Latest	McGraw Hill
5	SQL: The Complete Reference	James R. Groff	Latest	McGraw Hill
6	MySQL Cookbook	Paul DuBois	Latest	O'Reilly
7	Web Technologies	Uttam K. Roy	Latest	Oxford
8	Fundamentals of Database Systems	Elmasri & Navathe	Latest	Pearson

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Oracle Java Servlet & JSP Docs	https://docs.oracle.com/javaee
2	W3Schools (JSP, XML, SQL)	https://www.w3schools.com
3	MySQL Documentation	https://dev.mysql.com/doc
4	XML Tutorials (MDN)	https://developer.mozilla.org

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M.Sc. (Bioinformatics) semester II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2T02NCBIF06**	Databases in Life Sciences	2-0-1	**60**	02

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Understand database concepts, components, and relational database systems.
CLO2: Design and create database tables with keys, relationships, and data validation.
CLO3: Apply SQL queries for data manipulation and database operations.
CLO4: Understand biological data formats, preprocessing, and database architecture.
CLO5: Use bioinformatics tools and databases for data retrieval and integration.
CLO6: Apply data integration techniques and enterprise/open-source solutions in bioinformatics.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	**Database Management and SQL** Database as a collection of one or more related tables, popular database systems. Relation databases - Tables, Queries, Forms, and Reports; Understanding the importance of each database component. Creating a table, Understanding tables and relationships between them – Data types, Primary key, foreign key; Data validation. SQL (Structured Query Language), Database Operations.	Lecture-based learning, ICT-enabled learning, Collaborative learning	CLO1, CLO2, CLO3
II	**Biological Data & Bioinformatics Tools** Data cleaning, preprocessing and normalization. Database architecture – centralized and client-server systems. Information retrieval methods and data integration techniques. Formats of public repositories such as NCBI and ENSEMBL. Data federation and methods of data transfer like BioPAX and XML. Enterprise solutions – Oracle, IBM. Open-source tools – BioPerl, BioJava, BioSQL. Sequence Retrieval System (SRS) for accessing biological data.	ICT-enabled learning, Problem-based learning,	CLO4, CLO5, CLO6

- **(*) Learning Pedagogies/Methods**

Notes:

(1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(2) Acronyms/abbreviations of the terms can be placed in the above table.

(a) Interactive Classroom Lecture
(b) Classroom Lecture (CL)
(c) Seminars (Student-led and Faculty-moderated)
(d) Micro-Projects/Mini Research Tasks
(e) Industrial Visit/Field Visit/Institutional Visit

(f) Problem-Based Learning (PBL)
(g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
(h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
(i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
(j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
(k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
(l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(A)Internal Assessment

c. Internal Formative assessment (15)

(a) Quiz
(b) Assignment
(c) Seminar/Presentation
(d) Group Task
(e) Attendance

d. Internal Summative Assessment (10)

(a) Mid -Term

(B)External Assessment (25)

(b) End-Term

(B)Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2, CLO3	30	1	1	12	14
II	CLO4, CLO5, CLO6	32	1	1	10	12
		60	**02**	**02**	**22**	**26**

- Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	**50%**
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	**50%**

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- **CLOs – PLOs Matrix**

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	-	-	-	-	-	-	2	-
CLO2	2	3	2	-	-	-	-	-	3	-
CLO3	-	2	3	2	-	-	-	-	2	1
CLO4	-	-	2	3	2	-	-	-	3	2
CLO5	-	-	-	2	3	2	-	-	2	3
CLO6	-	-	-	-	2	3	2	2	-	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Database System Concepts	Abraham Silberschatz, Henry F. Korth, S. Sudarshan	6th Edition / 2010	McGraw-Hill
2	Fundamentals of Database Systems	Ramez Elmasri, Shamkant B. Navathe	6th Edition / 2011	Pearson
3	Bioinformatics: Sequence and Genome Analysis	David W. Mount	2nd Edition / 2004	Cold Spring Harbor Laboratory Press
4	Introduction to Bioinformatics	Arthur M. Lesk	4th Edition / 2013	Oxford University Press
5	SQL: The Complete Reference	James R. Groff, Paul N. Weinberg, Andrew J. Oppel	2nd Edition / 2009	McGraw-Hill

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NCBI – Biological databases and sequence data	https://www.ncbi.nlm.nih.gov
2	Ensembl – Genome browser and biological data	https://www.ensembl.org
3	W3Schools – SQL tutorials and practice	https://www.w3schools.com/sql
4	Oracle – Database and SQL documentation	https://docs.oracle.com