THE MAHATMA GANDHI UNIVERSITY

UNDERGRADUATE PROGRAMMES (HONOURS)

SYLLABUS

MGU-UGP (Honours)

(2024 Admission Onwards)

Faculty: Science

Expert Committee: Bioinformatics

Programme: Bachelor of Science (Honours) Bioinformatics

Mahatma Gandhi University

Priyadarshini Hills

Kottayam – 686560, Kerala, India

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PREFACE

Four Year Undergraduate Program (FYUGP) in Bioinformatics

Four Year Undergraduate Program (FYUGP) in Bioinformatics is designed to provide students with a comprehensive understanding of the intersection between biological and computational sciences.

This interdisciplinary program combines principles from biology, computer science, and information technology to analyze and interpret biological data. The curriculum is designed to provide students with a solid foundation in both biological sciences and computational techniques. Major discipline of this program is Bioinformatics while the other disciplines are Biotechnology and Computer Applications.

It is globally appreciated fact that Bioinformatics plays a crucial role in the era of big data biology, facilitating the analysis, interpretation, and management of biological information. This discipline has become an integral part of biological research and is essential for advancing fields such as genomics, personalized medicine, and drug discovery. Researchers in bioinformatics often collaborate with biologists, geneticists, clinicians, and computer scientists to address complex biological questions and solve practical problems in healthcare and agriculture. The FYUGP in Bioinformatics program aims to equip students with the knowledge and skills needed to generate and work with diverse biological data using information technology in a multidisciplinary ecosystem, and prepare them for careers in various fields, including healthcare, ecology, and biotechnology. The curriculum of the program is designed upholding the fact that the approaches and tools used in Bioinformatics are rapidly evolving.

The Program encourages curiosity, critical thinking, and a passion for exploring the frontiers of biological and computational sciences.

Updates on advancements in the field as well as critical feedback from students, faculty members, industrial and scientific communities, and other stake holders were carefully considered while preparing the curriculum. Nevertheless, this syllabus and curriculum is subject to periodic updates and revisions based on the advancements in the field and dynamic feedback from all the stake holders. We look forward to your active participation and success in the exciting journey of bioinformatics education!

Expert Committee Members

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Syllabus Index

Name of the Major: **Bioinformatics**

Semester: 1

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG1DSCBIF100	Fundamental IT for Bioinformatics	DSC A	4	5	3		2	
MG1MDCBIF100	Bioinformatics for Beginners	MDC	3	4	3	1		

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 2

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG2DSCBIF100	Biological data and management	DSC A	4	5	3		2	
MG2MDCBIF100	Biomolecules and Molecular Visualization	MDC	3	4	1	1	2	

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 3

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG3DSCBIF200	Sequence Informatics	DSC A	4	5	2	1	2	
MG3DSCBIF201	Applied Mathematics	DSC A	4	4	3	1		
MG3DSEBIF200	Biochemistry *	DSE	4	5	3	1	2	
MG3DSEBIF201	Linux and C mastery *							
MG3DSCBIF202	Sequence Analysis Using Bioinformatics	DSC B	4	5	3		2	
MG3MDCBIF200	Bioinformatics Frontiers	MDC	3	3	1	1	1	
MG3VACBIF200	Environmental Science and Human rights	VAC	3	3	2	1	0	

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

*DSE – (Elective Choose Either 1)

Semester: 4

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG4DSCBIF200	Data Structures & Algorithm	DSC A	4	5	2	1	2	
MG4DSCBIF201	Genomics & Computational Genome Analysis	DSC A	4	5	3		2	
MG4DSEBIF200	Biostatistics*	DSE	4	4	3	1		
MG4DSEBIF201	Cellular Enzymology *							
MG4DSCBIF202	Molecular Structures in Bioinformatics Perspective	DSC C	4	5	3		2	
MG4SECBIF200	Basic Molecular and Microbial Techniques	SEC	3	3	3		0	
MG4VACBIF200	Health, Nutrition & Wellness	VAC	3	3	2	1		

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

*DSE – (Elective Choose Either 1)

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG4INTBIF200	Internship	INT	2					

Semester: 5

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG5DSCBIF300	Perl & BioPerl Programming	DSC A	4	5	2	1	2	
MG5DSCBIF301	Systems & Synthetic Biology	DSC A	4	4	3	1		
MG5DSEBIF300	Evolutionary Biology & Molecular Phylogenetics *	DSE	4	4	3	1		
MG5DSEBIF301	Soft Computing Techniques *		4	4	3	1		
MG5DSEBIF302	Research Methods in Biological Sciences *		4	4	3	1		
MG5DSEBIF303	Unveiling Molecular Patterns Through Cheminformatics *		4	4	3	1		
MG5DSEBIF304	Genetic Engineering *		4	4	3	1		
MG5SECBIF300	Introduction to R Programming	SEC	3	4	1	1	2	

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

*DSE – (Elective Choose Any Three)

Semester: 6

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG6DSCBIF300	Structural Bioinformatics	DSC A	4	5	2	1	2	
MG6DSCBIF301	Python Programming	DSC A	4	5	2	1	2	
MG6DSEBIF300	NGS Data Analysis *	DSE	4	4	3	1		
MG6DSEBIF301	Bioinformatics: An Applied Perspective *		4	4	3	1		
MG6DSEBIF302	Viral Informatics *		4	4	3	1		
MG6DSEBIF303	Transcriptomics *		4	4	3	1		
MG6SECBIF300	Java Programming for Biologists	SEC	3	4	1	1	2	
MG6VACBIF300	Biosafety, Bioethics And IPR	VAC	3	3	2	1		

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

*DSE – (Elective Choose Any Two)

Semester: 7

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG7DCCBIF400	Pharmacogenomics & Personalized Medicine	DCC	4	4	3	1		
MG7DCCBIF401	Molecular Modelling & CADD	DCC	4	5	2	1	2	
MG7DCCBIF402	Immunoinformatics & Vaccine Design	DCC	4	4	3	1		
MG7DCEBIF400	Genomic Reconstitution Techniques	DCE	4	4	3	1		
MG7DCEBIF401	Nanobiotechnology	DCE	4	4	3	1		
MG7DCEBIF402	Knowledge Discovery from Biological Data	DCE	4	4	3	1		

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 8

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG8DCCBIF400	PHP Programming for handling Bioinformatics dataset	DCC	4	5	2	1	2	
MG8DCCBIF401	Clinical Genomics	DCC	4	5	2	1	2	
MG8DCEBIF400	Advanced Bioinformatics	DCE	4	5	2	1	2	
MG8DCEBIF401	Advanced R Programming	DCE	4	5	2	1	2	
MG8DCEBIF402	AI in Bioinformatics *	DCE	4	5	4	1		
MG8DCEBIF403	Environmental Informatics *	DCE	4	5	4	1		
MG8DCEBIF404	Pharmacogenomics & Drug Action *	DCE	4	5	4	1		
MG8PRJBIF400	Project(Research/Honours)	PRJ	12					

*DSE- (Elective Choose Any One)

Semester I

	Mahatma Gandhi University Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Fundamental IT for Bioinformatics**
Type of Course	**DSC A**
Course Code	**MG1DSCBIF100**
Course Level	**100-199**
Course Summary	The course aims to acquire basic knowledge in computer systems, hardware, software, computer networks, databases, and its application in the analysis of biological data-DNA, RNA and protein sequence.

Semester	I	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites	Basic idea about a computer.					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate the basic concepts of computer systems	U	1
2	Understand the architecture of computer networks	U	1
3	Acquire basic skills in basic programming logics and web designing	S	1
4	Understand the basics concepts in Bioinformatics	U	10
5	Apply different biological databases for sequence analysis	A	2
6	Analyze the biological data using different tools and softwares	An	1

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs.	CO No.
	1	**Computer- Fundamentals and Networks**	**20**	
	1.1	History, evolution, and classification of computers		1

1	1.2	Computer Hardware: CPU, memory, memory modules, secondary storage devices, Input, and output devices		1
	1.3	Introduction to operating systems - Windows, Linux, Android, Computer networks: Types of Networks, Network Topology, Network devices & cables, Wired and Wireless Network Architecture		1
	1.4	The basics of Internet-www, web browsers, web server, web pages -static & dynamic, IP address		2
	1.5	Internet Architecture and Protocols HTTP/HTTPS, FTP, SMTP, Domain Name, IP Addresses, DNS, SSL, Cryptography		2
2	**2**	**Introduction to programming**	**20**	
	2.1	History of programming		3
	2.2	Major programming languages		3
	2.3	Concepts of algorithms		3
	2.4	Language processing, compilers, interpreters, linkers, assemblers		3
	2.5	Overview of programming in biology		3
3	**3**	**Introduction to Web Designing**	**20**	
	3.1	Introduction to HTML, XML, DHTML		3
	3.2	Basic HTML tags, Tables, Lists, Links, Frames and Forms Cascading Style Sheet		3
	3.3	Introduction to CSS, advantages and disadvantages, style rule, CSS Properties, Text formatting, Class Ways of inserting CSS-External style sheets, Internal style sheets, inline style		3
	3.4	Introduction to JavaScript, Data Types, Variables & literals, Operators & Expressions, Placing text in browser, dialog boxes		3
	3.5	Decision making statements, Looping statements, Arrays & functions Events, Writing JavaScript, Form validation		3
4	**4**	**Bioinformatics - overview**	**15**	
	4.1	Introduction & History		4
	4.2	Areas of Bioinformatics and basic terminologies		4
	4.3	Human Genome Project		4
	4.4	Application of Bioinformatics in Medicine, Agriculture, Evolutionary studies, Forensics and other fields		4
5		**Teacher specific content**		
Teaching & Learning Approach		**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning		

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References

1. Leon, A., & Mathews, L. (1999). Fundamentals of information technology. Leon Press, New Delhi.
2. Kurose, J. F., & Ross, K. W. (2017). Computer Networking : A Top-Down Approach (7th ed.). Pearson.
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	Mahatma Gandhi University Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Bioinformatics for Beginners**
Type of Course	**MDC**
Course Code	**MG1MDCBIF100**
Course Level	**100-199**
Course Summary	To give an overview on fundamental biology in terms of molecular data and explore its relationship with advances in information technology culminating to evolve as a discipline of Bioinformatics. The major prospects, goals and applications in Bioinformatics are also introduced with basic experiments.

Semester	I	Credits:			3	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Total Hours
		1	1	1	0	60
Pre- requisites, if any	Basic computer knowledge					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understand the fundamental principles of biology and the role of biomolecules in cellular processes	U, K	1
2	Learn the key concepts and advancements in life sciences	Ap	2
3	Evaluate the developments in information technology that has contributed to evolution of Bioinformatics	Ap	3
4	Understand the role of Bioinformatics in modern research	U,An	6
5	Gain knowledge on the basic tools and softwares in Bioinformatics	U,A	3
6	Apply basic bioinformatics tools and softwares to analyze and predict molecular function	A,An	3

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Introduction to Bioinformatics and it's databases**	20	
	1.1	Cells as a basic unit of life. Hierarchical organization of life.		1,2
	1.2	Biomolecules: proteins, nucleic acids carbohydrates and lipids		1,2
	1.3	DNA, RNA, and proteins: Central Dogma of Molecular Biology		1,2
	1.4	History, Aim, Nature and scope of Bioinformatics, Role of internet and WWW in Bioinformatics		3
	1.5	Bioinformatics vs. Computational Biology		3
	1.6	Human Genome Project		4
	1.7	Introduction to internet resources and nature of biological data, Biological databases.		5,6
	1.8	Demonstrative study Accessing and retrieving biological data with suitable examples		5,6
	1.9	Different types of databases: primary, secondary. Sequence databases (NCBI, EMBL, SWISSPROT) and Structure databases- PDB		5,6
2	**2**	**Sequence analysis and Visualisation**	20	
	2.1	Basic concepts of sequence similarity, identity, and homology		5,6
	2.2	Introduction to Pairwise sequence alignment, BLAST and FASTA		5,6
	2.3	Global alignment and local alignment,		5,6
	2.4	Multiple Sequence Alignment- Clustal X, Clustal Omega		5,6
	2.5	Visualizing of data using visualization softwares		5,6
	2.6	Application of Bioinformatics: Computational proteomics, Personalized medicines, Molecular phylogenetics, Agriculture and Forestry, Immunology and Drug designing		
3	**3**	**Practicals**	20	
	3.1	Familiarise sequence Databases- NCBI, EMBL, SWISSPROT		5,6
	3.2	Structural databases- PDB		5,6
	3.3	Perform pair wise sequence alignment using BLAST & FASTA		5,6
	3.4	Perform MSA – Clustal X & Clustal Omega		5,6

	4	**Teacher specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 15 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 35 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (3 out of 5; 3x5=15 marks) Long essay)1 out of 3; 1x10=10 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References

1. Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Reece, J. B. (2016). Campbell Biology Books a La Carte Edition. Pearson College Div.
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16. Lengauer, T. (2010). Bioinformatics: From genomes to drugs. Wiley-VCH.

Semester II

	Mahatma Gandhi University Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Biological data and management**
Type of Course	**DSC A**
Course Code	**MG2DSCBIF100**
Course Level	**100-199**
Course Summary	This course introduces some basic concepts related to databases, types, designs, and architectures of biological databases. The primary focus is on data retrieval from major biological databases, including GenBank.

Semester	II	Credits: 4				Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre- requisites, if Any	Basic knowledge in computer skills					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Differentiate between data, databases and data models in detail	U	2,3
2	Understand the framework of different kinds of biological databases	U	1,3
3	Demonstrate different biological databases and tools	U	1
4	Articulate different search engines in biological databases	A	1
5	Understand various database resources	U	1

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Introduction to data and databases**	15	
	1.1	Overview of data and information, Basic terminologies in data-bite, field, record, files, database		1
	1.2	Databases- definition, basic features, history, types of Databases- Cloud, Hierarchical, network, object oriented, NOSQL		1
	1.3.	Data trends, data as a major resource, big data		1
	1.4	Overview of database management systems- Advantages, Architecture of database systems		1
	1.5	Levels of abstraction- Physical, logical, view. Schema. Data models- Relational and Entity relationship models. DBMS packages- Oracle, SQL- PL/SQL, SQL server, MySQL, Access		1
2	**2**	**Biological databases**	15	
	2.1	Nature and scope of Biological data		2
	2.2	Brief history of biological databases		2
	2.3	Classification of biological databases		2
	2.4	Primary databases, Secondary databases and examples of primary and secondary databases.		3
	2.5	NCBI- Databases of databases		2
3	**3**	**Sequence and structural databases**	15	
	3.1	GenBank and Refseq, EMBL, DDBJ Data retrieval systems & Genome browsers: Entrez, SRS File formats: GenBank, DDBJ, FASTA, PDB, SwissProt, conversion of file formats		4
	3.2	Primary protein sequence databases- SWISSPROT, PIR.		
	3.3	Sequence motifs Databases:- Prosite, ProDom, Pfam.		4
	3.4	Genome databases		4
	3.5	Structural Databases- PDB and MMDB		4
	3.6	Compound databases- PubChem, DRUGBANK, ChEMBL.		4
	3.7	Enzyme Catalysis Database- ENZYME.		4

	3.8	Disease databases- BCDB, OMIM.		4
	3.9	Bibliographic databases- PubMed, Medline		4
4	**4**	**Practicals**	**30**	
	4.1	Data retrieval using Nucleotide Sequence Databases: NCBI, RSV EMBL, PDB, DDBJ, GENBANK		5
	4.2	Data retrieval using Protein Sequence Databases: SwissProt, PIR, PROSITE		5
	4.3	Data retrieval using Structural Databases: PDB, MMDB		5
	4.4	Data retrieval using Chemical Databases: PubChem, Drugbank, Chemspider		5
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

REFERENCES

1. Byron, K., Herbert, K. G., & Jason. (2016). *Bioinformatics Database Systems*. CRC Press.

2. Principles of Biological Databases- L.N. Chavali, Prof. P.B. Kavi Kishor
3. Essential Bioinformatics- Xiong, Jin
4. Krishnakumar, M. S. (2007). *Introduction To Bioinformatics*.
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	Mahatma Gandhi University **Kottayam**

Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Biomolecules and Molecular Visualization**					
Type of Course	**MDC**					
Course Code	**MG2MDCBIF100**					
Course Level	**100-199**					
Course Summary	This course highlights the significant biomolecules that are vital to the biological processes, and uses of bioinformatics techniques to visualize them for drug discovery and other analysis.					
Semester	II	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		1	1	1	0	60
Pre-requisites, if any	Understanding about basic life sciences					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate the structure and function of biomolecules	U	1,10
2	Analyze the structure of DNA, RNA and their type	An	1
3	Understand different databases in Bioinformatics	A	1
4	Analyze sequences alignment by pairwise and multiple	An	1,2
5	Understand different visualization tools	A	1,3
6	Analyze biological data using different tools for molecular visualization	S	2,3

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Introduction to biomolecules and bioinformatics**	**18**	
	1.1	Carbohydrates, Functions & classification: mono, di, oligo and polysaccharides		1
	1.2	Lipids: classification saturated & unsaturated fatty acids, Properties & functions		1
	1.3	Protein: chemical properties, Motifs and domains, Peptide bond formation and properties. Composition and primary, secondary & tertiary structures		1
	1.4	Nucleic acid: Purine and pyrimidine bases, nucleosides, nucleotides, RNA and DNA. Forces, glycosidic bonds, rotational isomers. Stabilizing ordered forms of DNA (A, B and Z). Watson and crick model, base pairing types, Chargaff's rule, base stacking. Tertiary structure of DNA (Supercoiled DNA)		2
	1.5	Types of RNA- mRNA, rRNA & tRNA (uses)		2
	1.6	Introduction to Bioinformatics, Branches of bioinformatics		3
	1.7	Biological databases: Sequence databases, structure databases, NCBI.		3
	1.8	Pairwise sequence alignment- BLAST and FASTA. Multiple sequence alignment and its applications		4
2	**2**	**Molecular visualization and tools**	**12**	
	2.1	Molecular visualizations: Ball and stick models, Space filling models, surfaces and Ribbon diagram		5,6
	2.2	Molecular Graphics, Different types of molecular graphics		5,6
	2.3	Visualization Tools: Rasmol, PyMOL, Chime, Swiss PDB Viewer, Webmol, MOLMOL		5,6
	2.4	Cn3D, and MolScript, Locus Linker, ORF Finder, Map Viewer		5,6
3	**3**	**Practicals**	**30**	
	3.1	Acquire basic skill sets in Biological databases: NCBI, PDB, SWISSPROT, GENBANK		3

	3.2	Experiments on sequence analysis tools BLAST, FASTA and ORF Finder		4
	3.3	Acquire basic skill sets in Bioinformatics Tools: RASMOL, PYMOL, Swiss PDB Viewer		6
4	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment (CCA)** **Theory: 15 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	D. Semester End examination **Theory: 35 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (3 out of 5; 3x5=15 marks) Long essay)1 out of 3; 1x10=10 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

Reference:

1. Principles of Biochemistry Albert Lehninger CBS publishers 2nd edition 1993
2. Biochemistry – J.M.Berg, J.L.Tymockzo, L.Stryer, 5th ed
3. J. David Rawn. (1989). *Biochemistry*
4. Xiong, J. (2006). *Essential Bioinformatics*. Cambridge University Press.
5. Felix Autenrieth Barry Isralewitz Zaida Luthey-Schulten Anurag Sethi Taras Pogorelov (June 2005)-Bioinformatics and Sequence Alignment
6. Fulekar, M. H. (2009). *Bioinformatics*. Springer Science & Business Media

Semester III

MGU-UGP (HONOURS)

Syllabus

	Mahatma Gandhi University **Kottayam**

Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Sequence Informatics**					
Type of Course	**DSC A**					
Course Code	**MG3DSCBIF200**					
Course Level	**200-299**					
Course Summary & Justification	The course aims to analyze sequences using Bioinformatics tools, softwares and algorithms. Usage of Bioinformatics tools and software packages for sequence manipulation and analysis.					
Semester	III		Credits		4	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**75**
		2	1	1	0	
Pre-requisites	Basic understanding about nucleic acid and protein sequences					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic concepts in sequencing	U	1,3
2	Understand the principles and concepts of sequence analysis in bioinformatics	U	2,3
3	Analyze sequence using Bioinformatics tools	An	3
4	Apply sequence analysis to predict protein structures	A	2,6
5	Apply sequence analysis to predict gene structure and functions	A	2,6
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
	1	**Introduction to Sequencing and sequence alignment**	**18**	

1	1.1	Introduction, history and methods for sequencing		1
	1.2	Sanger sequencing, Maxam & Gilbert sequencing		1
	1.3	Next Generation Sequencing		2
	1.4	Concept of sequence alignments: Identity, Similarity, homology, gaps in sequence alignment, types and scoring matrix- PAM, BLOSUM		2
	1.5	Pairwise sequence alignment: Dot plot, BLAST and its variants, Needleman and Wunch algorithm, Smith Waterman		2
	1.6	Multiple sequence alignment: algorithms and tools -Clustal W, Clustal Omega, T Coffee		2
2	2.1	**Sequence patterns**	**12**	
	2.2	Basics concepts & definition of sequence pattern, profile & motifs		2
	2.3	Various types of pattern representations vs consensus, regular expression & sequence profiles, Profile based database searches using PSI BLAST & PHI- BLAST		3
3	**3**	**Application of sequence analysis**	**15**	
	3.1	Evolutionary analysis, species identification, Protein family identification and taxonomic classification		4,5
	3.2	Functional annotation		4,5
4	**4**	**Practicals**	**30**	
	4.1	Sequence Analysis using BLAST and FASTA		2
	4.2	Multiple Sequence Alignment tools: Clustal Omega, MUSCLE		3
	4.3	Phylogenetic Analysis using Phylip, PhyloSift		3
	4.4	Motif Analysis databases and tools: PROSITE, Pfam, MEME suite		5
	4.5	Functional Annotation databases and tools:InterPro, Gene Ontology resourse, PANTHER		5
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **E. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	F. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References:

1. Mount, D. W., & Harbor, S. (2006). *Bioinformatics : sequence and genome analysis*. Cold Spring Harbor Laboratory Press, [Post], Cop.
2. Lesk, A. M. (2017). Introduction to Bioinformatics (4th ed.). Oxford University Press.
3. Barnes, M. R., & Gray, I. C. (2003). *Bioinformatics for Geneticists*. John Wiley & Sons.
4. Deonier, R. C., TavaréS., & Waterman, M. S. (2005). *Computational Genome Analysis An Introduction*. New York, Ny Springer Science+Business Media, Inc.
5. Xiong, J. (2019). Essential Bioinformatics. Cambridge, MA: Academic Press.
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7. Ramsden, J., & Springerlink (Online Service. (2009). *Bioinformatics : An Introduction*. Springer London.
8. Zhumur Ghosh, & Bibekanand Mallick. (2014). *Bioinformatics : principles and applications*. Oxford University Press.
9. Eidhammer, I., Jonassen, I., & Taylor, W. R. (2004). Protein Bioinformatics: An algorithmic approach to sequence and structure analysis. Cambridge University Press.

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Applied Mathematics**
Type of Course	**DSC A**
Course Code	**MG3DSCBIF201**
Course Level	**200-299**
Course Summary & Justification	Essential Mathematics aims to understand basic concepts in Mathematics and apply this concept in Biological data analysis.

Semester	**III**	Credits			**4**	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**60**
		3	1	0	0	
Pre-requisites						

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains	PO No
1.	Understand the basic elements of sets	U	1
2.	Develop critical thinking skills in analyzing and solving problems related to sets, operations, and functions	An	1
3.	Ability to apply logical reasoning to solve mathematical problems	A	2
4.	Application of logical reasoning to everyday situations	A	2,5,10
5.	Recognition and characterization of various types of graphs	K	1
6.	Understand and apply basic graph operations	U	1
7.	Understand the properties of matrices and the rules governing matrix algebra, such as associativity and distributivity	U	3
8.	Applications of Biostatistics to Solve Biological Problems	Ap	2,6

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1.**	**Set Theory and Matrices**	**15**	
	1.1	Introduction to Set: Basic definitions: elements, notation and set representation. Finite and infinite set, equal sets and equivalent sets, null set, singleton set, subsets, superset, Power set, universal set, disjoint sets.		1
	1.2	Operations on Sets; Union, intersection, and difference, complement of a set. Ordered pair, Cartesian product.		2
	1.3	Important Laws; commutative law, associative law, distributive law, D'Morgan's law. Functions and Relation; definition, Domain, co-domain, and range, Relations and their properties, Equivalence relation.		2
	1.4	Introduction to Matrices and Basic Operations: Definition of matrices and their notation. Matrix operations; addition, subtraction, scalar multiplication, matrix multiplication.		2
	1.5	Determinants; Definition and properties of determinants; co-factor, singular and non singular matrix, rank of a matrix. Representing systems of linear equations as matrices. Solution of linear equations by matrix method		7
2	**2.**	**Mathematical logic.**	**15**	
	2.1	Overview of logic and its importance in mathematics. Propositional calculus.		3
	2.2	Basic logic operations- conjunction, disjunction, negation.		2
	2.3	Conditional and bi-conditional, converse, inverse and contrapositive statements.		3
	2.4	Truth tables and logical equivalence. Tautologies and Contradictions.		4
	2.5	Logical Laws and Equivalences: Basic laws (identity, domination, double negation, idempotent). De Morgan's laws. Commutative, associative, and distributive laws.		4
3	**3.**	**Graph Theory.**	**15**	
	3.1	Introduction to Graphs: Basic definitions: vertices, edges, directed and undirected graphs.		5
	3.2	Graph representation: adjacency matrix, adjacency list.		5
	3.3	Graph Types: Simple graphs, multigraphs, pseudographs; Directed and undirected graphs; Weighted graphs, connected graphs.		5

	3.4	Graph Operations: Subgraphs, induced subgraphs; Complements, unions, and intersections; Graph isomorphism.		6
	3.5	Paths and Cycles: Paths and cycles in graphs; Eulerian and Hamiltonian paths and cycles; Connectivity.		6
	3.6	**Trees:** Tree definitions and properties; Spanning trees; Rooted trees and binary trees, Kruskal's Algorithm.		6
4	**4.**	**Biostatistics**	**15**	
	4.1	Introduction to Biostatistics: application, data and variables, levels of measurements		8
	4.2	Measures of central tendency and dispersion. data visualization		8
	4.3	Probability distribution: continuous and discrete		8
	4.4	Statistical inference: testing of hypothesis		8
	4.5	Parametric testing		8
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

REFERENCES

1. Discrete Mathematics, Vatsa B.S, Wishwa Prakashan (A Division of New Age International Pvt. Ltd), New Delhi, 2002, 3rd Edition.
2. Dr. Sharma J.K, Discrete Mathematics Trinity Press (An imprint of Laxmi Publications Pvt. Ltd. New Delhi, 2015, 4th Edition.

3. Graph theory, Harary, Frank; Narosa Publishing House Pvt. Ltd. New Delhi, 2001
4. Graph theory Reinhard Diestel., Springer (India) Pvt. Ltd, 2000. 2nd Edition.
5. A TextBook Of Graph Theory; Balakrishnan R; Springer (India) Pvt. Ltd, 2000.
6. David W. Lewis - Matrix Theory (Allied)
7. David W. Lewis - Matrix Theory (Allied)
8. Shanthi Narayanan & P.K. Mittal, A Text Book of Matrices, S. Chand
9. Narsingh Deo – Graph Theory with Applications to Engineering and Computer Science
10. A Text Book of Graph Theory R. Balakrishnan, K. Ranganathan.

SUGGESTED READINGS

1. Discrete Mathematics Rajendra Akerkar, Rupali Akerkar, Pearson Education.
2. Introduction to Graph Theory; Douglas B. West; Prentice-Hall of India Pvt. Ltd, 2001; 2nd Edition.
3. Discrete Mathematics and its application; Kenneth H. Rosen; Tata McGraw Hill Publishing Company Ltd. New Delhi; 2005; 5th Edition.
4. Thomas Calculus; Thomas George B; Pearson India Education Services Pvt. Ltd.Utter Pradesh; 2016; 12th Edition.
5. Linear Algebra; Surjeet Singh; Vikas Publishing House Pvt. Ltd; New Delhi 2006.
6. Mathematical Models in Biology: An Introduction; Cambridge University Press, UK; 2004 1st Edition

	Mahatma Gandhi University Kottayam						
Programme	**BSc (Hons) BIOINFORMATICS**						
Course Name	**Biochemistry**						
Type of Course	**DSE**						
Course Code	**MG3DSEBIF200**						
Course Level	**200-299**						
Course Summary	This course explores biochemistry and molecular biology, focusing on biomolecules' structural and functional properties, carbohydrates, proteins, and nucleic acids, and practical biochemical estimation techniques.						
Semester	III	Credits: 4				Total Hours	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	75	
		2	1	1	0		
Pre-requisites, if any	Basic concepts on biomolecules						

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the structural and functional properties of biomolecules in living organisms	K	1
2	Articulate the structure of carbohydrates, lipids, nucleic acids and their biological functions	U	1
3	Analyze and identify key structural motifs and domains in proteins	An	2
4	Analyze the structural variations among different types of DNA and RNA molecules	An	2
5	Articulate the overview of cellular respiration and metabolism	E	1
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	1	**Chemistry of Carbohydrates, Amino acids and Proteins**	15	
	1.1	Definition and classification of carbohydrates; isomerism in carbohydrates; Structure and Function of Monosaccharides; glucose, fructose, and ribose; Structure and function of disaccharides; maltose, sucrose, lactose		1,2
	1.2	Structural diversity of polysaccharides; starch, cellulose, glycogen; Biological roles of polysaccharides;		1,2
	1.3	Definition and classification of amino acids; Structure of amino acids: essential amino acids; non-protein amino acids; Isomerism in amino acids		3
	1.4	Peptide bond formation and its significance; Primary, secondary, tertiary, and quaternary protein structures; Forces stabilizing protein structures		3
	1.5	Ramachandran plot; Domains and structural motifs in proteins and its Functional significance		3
	1.6	Protein folding, Role of molecular chaperones in protein folding.		3
2	2	**Chemistry of Lipids and nucleic acids**	15	
	2.1	Definition, classification and properties of lipids; fatty acids, triglycerides, phospholipids, and steroids		2
	2.2	Structure and properties of fatty acids, Isomerism in fats, Essential Fatty acids.		2
	2.3	Structure and function of phospholipids, Glycolipids and steroids (Eicosanoids: prostaglandins and leukotrienes).		2
	2.4	Composition and structure of nucleotides; Purines and pyrimidines		4
	2.5	Base pairing rules and hydrogen bonding in DNA and RNA, Watson-Crick model of DNA structure, B-form, A-form, and Z-form DNA, Antiparallel orientation of DNA strands, Major and minor grooves in DNA		4
	2.6	Differences between RNA and DNA structure, Types of RNA, Secondary structures in RNA		4
3	3	**Cellular respiration**	15	

	3.1	Introduction to metabolism: anabolism and catabolism		5
	3.2	Oxidative and substrate level phosphorylation		5
	3.3	Glycolysis an overview		5
	3.4	Krebs cycle an overview		5
	3.5	ETC an overview		5
4	**4**	**Practicals**	**30**	
	4.1	Estimation of carbohydrates using anthrone method		1
	4.2	Estimation of protein using Lowry's or Biuret method		2
	4.3	Estimation of nucleic acid using DPA method		1
	4.4	Separation of amino acid using paper chromatography		2
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks**

	Lab examination: 25 Viva voce :5 Record: 5

References

1. Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox
2. Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer
3. Biochemistry" by Donald Voet, Judith G. Voet, and Charlotte W. Pratt
4. Harper's Illustrated Biochemistry" by Victor W. Rodwell, David Bender, Kathleen M. Botham, and Peter J. Kennelly
5. Biochemistry: The Molecular Basis of Life" by Trudy McKee and James R. McKee

SUGGESTED READINGS

1. Introduction to Protein Science: Architecture, Function, and Genomics by Arthur M. Lesk
2. Biochemistry and Molecular Biology by William H. Elliott, Daphne C. Elliott, and J. Malcolm Easton
3. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter
4. Essential Biochemistry by Charlotte W. Pratt and Kathleen Cornely
5. Lippincott Illustrated Reviews: Biochemistry by Denise R. Ferrier

	Mahatma Gandhi University, Kottayam					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Linux and C Mastery**					
Type of Course	**DSE**					
Course Code	**MG3DSEBIF201**					
Course Level	**200-299**					
Course Summary & Justification	This course equips students with a solid foundation in Linux administration, command-line proficiency, and system troubleshooting.					
Semester	III	Credits 4				Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**75**
		2	1	1	0	
Pre-requisites	Basic computer knowledge					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understanding the basic concepts and operators in C	U	2,3
2	Explain different decision-making statements and data types in C	A	1,2,3
3	Understand the basic concepts ,functions and applications of Linux OS	U	3
4	Usage of basic commands in Linux	U	3
5	Create simple command line programs	C	1
6	Gain proficiency in simple and advanced command line programs	A	1
7	Understand basic shell scripting	U	1
8	Create simple and advanced shell script programs	C	1
9	Understand advanced shell programming	U	1

**Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	1	**Introduction to C programming**	15	
	1.1	Basic structure, C Character set, C tokens- identifiers, keywords, strings, constants, variables in C, Operators & Expressions		1
	1.2	Data Types-built in, derived, user defined, Preprocessors in C-#include and #define, Managing Input & Output Functions		1
	1.3	Control Statements- If statement, Switch statement, looping statements, jumping statements		2
	1.4	Arrays:1-D,2-D, character arrays		2
	1.5	Functions, Recursion, Structure, Union, Pointers		2
2	2	**The Linux OS and commands**	15	
	2.1	Introduction and functions of an OS. History, versions, features and applications of Linux; Introduction to Kernel and Shell of Linux		3
	2.2	Linux command line: File and directory management, Navigating the file system using commands; Text processing and manipulation using command line tools		4
	2.3	File permissions in Linux, Commands for system administration, Redirection and pipes in Linux, Introduction to file compressions and archives, Configuring the linux system, Network utility commands		5,6
	2.4	Introduction to Shell scripting in Linux- different types of shells, Writing shell scripts, Basics of shell programming, Operators, Managing input and output		7
	3	**Shell Programming**	15	
	3.1	Conditional statements in shell scripting: if, if…else, elif, nested if		8
	3.2	Bash case statements		8
	3.3	Loops in shell scripting		8
	3.4	Error handling and debugging		8
	3.5	Shell scripting best practices		8
	4	**Practicals**	30	

4	4.1	Usage of Linux commands in File and directory commands, Text processing, Redirection		4,5,6
	4.2	Pipes in linux		4,5,6
	4.3	Shell scripting programs for operators in linux		7,8
	4.4	Shell scripting programs input and output		7,8
	4.5	Shell scripting programs conditional statements, case statements and loops		7,8
	4.6	Writing programs using Basic operations, Input/ Output functions, Decision making statements, loop control structure, arrays, character arrays, Character strings, Pointers, Structure, union		1,2
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References

1. Negus, C. (2018). *Linux Bible.* Wiley.
2. Shotts, W. E. Jr. (2012). *The Linux Command Line: A Complete Introduction.* No Starch Press.
3. Nemeth, E., Snyder, G., Hein, T. R., & Whaley, B. (2017). *UNIX and Linux System Administration Handbook.* Addison-Wesley.
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5. Kanetkar, Y. (2019). *UNIX Shell Programming. In Shell Scripting & Unix Programming*. BPB Publications.
6. Mathew, N., & Stones, R. (2007). *Beginning Linux Programming. Indianapolis, IN*: Wiley Publishing**.**

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Sequence Analysis Using Bioinformatics**
Type of Course	**DSC B**
Course Code	**MG3DSCBIF202**
Course Level	**200-299**
Course Summary & Justification	Sequence analysis in bioinformatics is a foundational tool that supports a wide range of biological research, from understanding the basic mechanisms of life to developing new medical treatments and biotechnological applications.

Semester	III		Credits 4			Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**75**
		3	0	1	0	
Pre-requisites	Basic understanding about nucleic acid and protein sequences					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic concepts in sequence alignment	U	1,3
2	Understand the principles and concepts of recognising motifs and patterns	U	2,3
3	Analyze sequence using Bioinformatics tools	An	3
4	Apply sequence analysis for gene prediction	A	2,6
5	Apply sequence analysis to predict gene structure and functions	A	2,6
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	1	**Introduction to Sequence alignment**	18	
	1.1	Concept of sequence alignments: Identity, Similarity, homology, gaps in sequence alignment, types and scoring matrix- PAM, BLOSUM		1
	1.2	Pairwise sequence alignment: Dot plot, BLAST and its variants, Needleman and Wunch algorithm, Smith Waterman		1
	1.3	Multiple sequence alignment: algorithms and tools - Clustal W, Clustal Omega, T Coffee		1,3
2	2.1	**Motifs and pattern recognition**	12	
	2.2	Basics concepts & definition of sequence pattern, profile & motifs		2
	2.3	Various types of pattern representations vs consensus, regular expression & sequence profiles, Profile based database searches using PSI BLAST & PHI- BLAST		2
	2.4	Identification of motif. Use of MEME.		2,3
	2.5	Regular expression and Hidden Markov Models		2
3	3	**Gene prediction and Annotation**	15	
	3.1	Gene prediction and use of Tools like AUGUSTUS and GeneMark		3,4
	3.2	Annotation with the help of GenBank and Ensembl		4,5
4	4	**Practicals**	30	
	4.1	Multiple Sequence Alignment tools: Clustal Omega, MUSCLE		1,3
	4.2	Motif Analysis databases and tools: PROSITE, Pfam, MEME suite		2,3
	4.3	Functional Annotation databases and tools:InterPro, Gene Ontology resourse, PANTHER		3,5
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration

Assessment Types	MODE OF ASSESSMENT **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References:

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	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Bioinformatics Frontiers**
Type of Course	**MDC**
Course Code	**MG3MDCBIF200**
Course Level	**200-299**
Course Summary & Justification	This course is a comprehensive journey through the basic principles and advanced applications of Bioinformatics. It is designed to meet the growing demand for professionals with expertise in interdisciplinary Bioinformatics.

Semester	**III**	Credits			**3**	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	45
		1	1	1	0	
Pre-requisites	Enthusiasm for bioinformatics exploration and a commitment to actively participate in the course. Willingness to engage in independent study and hands-on practical exercises.					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply online resources and databases to gain access to biological data and literature information	A	2,10
2	Manipulate online and offline tools for sequence analysis and result.	A	2
3	Interpret genomic and proteomic data to understand the underlying biological processes	U	2
4	Outline the principles of transcriptomics and proteomics	K	1
5	Outline the various stages of drug discovery and fundamentals of immune informatics	K	1
6	Define Pharmacogenomics and its fundamental principles	K	1
7	Summarize the applications of AI and machine learning in bioinformatics	K	2,6
8	Articulate Systems and Synthetic Biology	U	1

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Foundations of Bioinformatics, Genomics, Transcriptomics and Proteomics**	10	
	1.1	Overview of biological databases: GenBank, UniProt, PDB)		1
	1.2	Sequence alignment algorithms: pairwise and multiple: BLAST and ClustalW		2
	1.4	Phylogenetics analysis, Use of PHYLIP		2
	1.5	Introduction to genomics: Genome sequencing techniques: Next-Generation Sequencing (NGS)		3
	1.6	Transcriptomics: Basics of gene expression analysis		4
	1.7	Proteomics: Understanding the dynamic nature of the proteome.		3
	1.8	Protein prediction tools.		4
2	**2**	**CADD and Immunoinformatics**	10	
	2.1	Overview of drug discovery stages		5
	2.2	Molecular Docking		5
	2.3	Introduction to Immunoinformatics		5
	2.4	Computational approaches to predict epitopes		5
3	**3**	**Personalized Medicine, Pharmacogenomics and other trends**	10	
	3.1	Introduction to Personalized Medicine: Definition and principles. Role of genetics and genomics in personalized medicine		6

	3.2	Basics of pharmacogenomics		6
	3.3	Overview of AI and machine learning applications in bioinformatics. AI and Machine Learning in Drug Discovery		7
	3.4	Approaches to Bioinformatics through Systems and Synthetic Biology		8
4	**4**	**Practicals**	**15**	
	4.1	Familiarize with the various databases given in the syllabus: GenBank, UniProt, PDB, Genome database		1
	4.2	Familiarize sequence analysis tool: BLAST, Clustal Omega		2
	4.3	Familiarize different phylogenetic tools: PHYLIP		3
	4.4	Molecular Visualizing Tool: Rasmol, Pymol		3
	4.5	Protein Sequence analysis Tool: Any two tools from ExPASy		4
	4.6	Molecular Docking: ArgusLab		4
	4.7	Epitope prediction Tool: Immune Epitope Database and Analysis Resource (IEDB) tools		5
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 15 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement

	B. Semester End examination **Theory: 35 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (3 out of 5; 3x5=15 marks) Long essay)1 out of 3; 1x10=10 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References

1. Mount, D. W., & Harbor, S. (2006). *Bioinformatics : sequence and genome analysis*. Cold Spring Harbor Laboratory Press, [Post], Cop.
2. Pevsner, J. (2013). *Bioinformatics and Functional Genomics*. John Wiley & Sons.
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15. Low, L. W. Y., & Tammi, M. T. (2017). Bioinformatics: A Practical Handbook Of Next Generation Sequencing And Its Applications. World Scientific Publishing Co Pte Ltd.

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	Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Environmental Science and Human Rights**					
Type of Course	**VAC**					
Course Code	**MG3VACBIF200**					
Course Level	**200-299**					
Course Summary	This course introduces the basic principles of environmental biology, population, and the relationship between humans and the natural world.					
Semester	III	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	1	0	0	45
Pre-requisites	Environmental awareness					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate the basic concepts of Ecosystems and its functioning	U, K	1,10
2	Understand the different resources available on earth, their protection, conservation, the factors polluting the environment, their impacts and control measures	U, K	10
3	Understand global environmental problems and its impact on human well being	An	6,7
4	Create a consciousness regarding Biodiversity, environmental issues & conservation strategies	C	6,7
5	Develop the real sense of Human rights – its concepts & manifestations	U	6,7,8

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**ECOSYSTEM, CONCEPTS OF POPULATION AND COMMUNITY**	**15**	
	1.1	Abiotic (Sunlight, temperature, soil, water, atmosphere) and Biotic components (Producers, consumers, decomposers), Ecological pyramid- number, biomass, energy,		1
	1.2	Productivity-Food Chain-Food Web-Energy Flow. Types of Ecosystem: Terrestrial-Forest-Grassland-Desert, Aquatic-Marine Fresh water, Wetland Biome		1
	1.3	Liebig's and Shelford's laws of limiting factors.		1
	1.4	Renewable resources (solar, wind, hydroelectric, biomass and geothermal) and Nonrenewable resources (mineral and metal ore, fossil fuels)		2
	1.5	Population attributes- Population growth forms, Basic concepts of growth rates, density, natality, mortality, growth curves		2
	1.6	Characteristics of a community: Species diversity- richness, evenness, stratification, dominance, ecological indicators, Ecotone and Edge effect, Keystone species, Concepts of Ecological Niche and Guild, Ecological succession		2
2	**2.**	**BIODIVERSITY AND ENVIRONMENTAL ISSUES**	**15**	
	2.1	Introduction to Biodiversity: Types of biodiversity- Alpha, Beta and Gamma diversity.		2
	2.2	Concept and importance of Biodiversity: Levels of Biodiversity-Species diversity, Genetic diversity, Microbial, Ecosystem diversity, Biodiversity hotspots in India		4
	2.3	Global Environmental Issues: Ozone depletion, Greenhouse effect, Global warming, Climate change, Acid rain, Oil spills, Nuclear accidents, IPCC/UNFCC		2,3
	2.4	National Environmental issues: Deforestation, forest fire, pollution (air, water, soil, noise thermal, nuclear)		2,3
	2.5	Local Environmental issues: Landscape alteration, sand mining, quarrying, changing crop pattern, conversion of paddy lands		2,3
	2.6	Threats to water resources of Kerala: Degrading Mangrove and wetland ecosystems of Kerala, RAMSAR sites, Marine ecosystem crisis- pollution, overfishing etc.		2
3	**3**	**CONSERVATION OF BIODIVERSITY AND HUMAN RIGHTS**	**15**	
	3.1	Protected area concept Sanctuary, National Park, Biosphere reserve, Core Zone, Buffer Zone, Corridor concept. Conservation reserves		4
	3.2	IUCN categories - extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern and data deficient. Red and Green Data Books.		4

	3.3	Man–animal conflict (Tiger, Elephant,) – causes and concern. Water conservation- rainwater harvesting, watershed management		4
	3.4	Environment laws: The Wildlife Protection Act, 1972, Biodiversity Act, 2002		5
	3.5	An Introduction and history to Human Rights, Meaning, concept and development. Basic International Human Rights Documents - UDHR, ICCPR, ICESCR-Value dimensions of Human Rights		5
	3.6	Human Rights National Perspective Human Rights in Indian Constitution Mechanisms for checking violations of human rights, National human right commission, and Constitutional provisions related to Human rights.		5
4	4	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Report on Environmental visit/ Assignment/Test paper
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks)

References

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Semester IV

	Mahatma Gandhi University, Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Data Structures & Algorithm**
Type of Course	**DSC A**
Course Code	**MG4DSCBIF200**
Course Level	**200-299**
Course Summary & Justification	This course "Data Structures and Algorithms" will help the students fully grasp basic data structures and algorithms. By the end of this course, students will know how to make algorithms that work well, and pick the right data structures for different situations.

Semester	IV		Credits		4	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	75
		2	1	1	0	

Pre-requisites	Fundamentals of Programming language

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the concepts of problem solving, algorithms and data structures.	U	1,10
2	Analyze the performance of algorithms	An	1
3	understand data representation, implementation, and applications of Arrays & linked lists	U	1,2
4	understand data representation, implementation, and applications of Stacks & Queues	U	1,2
5	Understand & apply various algorithm designing techniques	U, A	2
6	Understand & apply various data searching and sorting techniques	U, A	2

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Introduction to Problem Solving**	**14**	
	1.1	Concept of Problem solving- Introduction to Algorithms, Characteristics of Algorithms, randomized algorithms		1
	1.2	Pseudocode and Flowchart, Abstract Data Types (ADT), Set as an ADT		1
	1.3	Introduction to Data structures-types of DS, Classification of DS,basic operation on DS		1
	1.4	Complexity of Algorithms-time & space, Amortised complexity		2
	1.5	Asymptotic Notations-Big O, Omega, Theta; best ,worst and average case		2
2	2	**Arrays & Linked Lists, Stacks & Queues**	**18**	
	2.1	Arrays-: Array as an ADT, Storage Representation of an Array – Row major and Column major		3
	2.2	Introduction to Multidimensional Arrays. Concept of Ordered List Array operations-Insertion, deletion		3
	2.3	Concept of Linked List- Comparison of Sequential and Linked Organizations, Linked List using Dynamic Memory Management, Linked List as an ADT,		3
	2.4	Introduction to types of Linked List,-singly linked, doubly linked. Linked List operations-traversing, insertion, deletion		3
	2.5	Stack- Stack as an ADT, Representation and Implementation of Stack using Sequential and Linked Organization. Stack operations-Push,Pop		4
	2.6	Applications of Stack- Simulating Recursion using Stack, Arithmetic Expression Conversion and Evaluation, Reversing a String		4
	2.7	Queue- Queue as an ADT, Representation, and Implementation		4
	2.8	Insertion & deletion in queue, Applications of queue		4
	2.9	Types of Queues- Linear Queue, Circular Queue, Priority Queue, Double Ended Queue.		4
3	3	**Designing, sorting and searching Techniques**	**13**	

	3.1	Divide & conquer,maxmin .Greedy method,kanpsack		5
	3.2	Dynamic programming- multistage graph. Spanning tree,minimum spanning tree,prims algorithm,kruskal's algorithm,all pairs shortest path		5
	3.3	Branch & bound, least cost search. Backtracking,8 queens' problem		5
	3.4	Need of Sorting and Searching Bubble Sort, Insertion Sort, Selection Sort,Quick Sort and Merge Sort, Radix Sort, Shell Sort.		6
	3.5	Searching- Linear Search, Binary Search.Binary tree, complete binary tree, Tree searching techniques-DFS, BFS		6
4	4	**Practicals**	**30**	
	4.1	Insertion and deletion in array		3
	4.2	Searching in an array		3
	4.3	Sorting the array		3
	4.4	Insertion and deletion in linked list		3
	4.5	Push operation in stack		4
	4.6	Pop operation in stack		4
	4.7	Insertion and deletion in queue		4
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars

	Practical: 15 Marks Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References

1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekharan, Computer algorithms/C++, Second Edition, Universities Press.
2. Anany Levitin- Introduction to design and analysis of algorithms, Third Edition, Addison Wesley Low price edition.
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4. "Fundamentals of data structure in C" Horowitz, Sahani & Freed, Computer Science Press.
5. "Fundamentals of Data Structure" (Schaum's Series) Tata-McGraw-Hill.

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Genomics & Computational Genome Analysis**
Type of Course	**DSC A**
Course Code	**MG4DSCBIF201**
Course Level	**200-299**
Course Summary & Justification	This course provides an overview of various functional components in the genome, applying diverse wet labs and *in silico* techniques. A detailed analysis of components of the Human Genome and their functions.

Semester	IV	Credits 4				Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**75**
		3	0	1	0	
Pre-requisites						

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic concepts in Genomics	U	1,10
2	Understand various genome analysis techniques	U	1
3	Articulate HGP and its role in modern biology	Ap	1
4	Understand genomic components	An, R	1
5	Analyze and interpret genetic maps and physical maps	An, A	2
6	Articulate the role of computers in genome analysis	Ap	1,3
7	Apply the knowledge in genomic tools to predict genome components	A	2
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	1	**Strategies in genome analysis and HGP**	**15**	
	1.1	Genes and Genomes- their features, Prokaryotic and eukaryotic genomes		1
	1.2	Genetic mapping: recombination frequency and genetic linkage, Centi-Morgan, LOD scores		2
	1.3	Physical mapping: fluorescent *in situ* hybridization, Radiation hybrid mapping, STS mapping. DNA markers – RFLP, SSLP and SNPs		2
	1.4	Human Genome Project- history and objectives. Strategies of sequencing: bac to bac sequencing vs. whole genome shotgun sequencing		3
	1.5	Completion and Assembling human genome, Outcomes and applications of HGP. Ethical issues related to sequencing, Other genome projects: ENCODE project, HapMap, 1000 genome project.		3
2	**2**	**Components of Human Genome:**	**12**	
	2.1	Nuclear and mitochondrial genome, Comparison with other genomes		4
	2.2	Genes and their features, Gene density and distribution, Gene mutation		4
	2.3	Functional RNA's in human Genome		3,5
	2.4	DNA repeats; satellite DNA, transposons and retrotransposons		6
	2.5	Regulatory elements, Pseudogenes and other components		6
3	**3**	**Genome analysis techniques and Computational genomics**	**18**	
	3.1	Determining functions of genomic components		6,7
	3.2	Microarray: principle and methodology, oligonucleotide arrays, in situ synthesized arrays. Basics of image analysis		6,7
	3.3	RNASeq- Basics and its applications		6,7
	3.4	Emergence of NGS technologies. ChipSeq, Metagenomics		7
	3.5	Genome assembly; mapping and *de novo* assembly		7

	3.6	Genome annotation: structural and functional annotation		7
	3.7	Gene prediction in prokaryotes and eukaryotes: homology-based and ab initio approaches.		7
	3.8	Variant analysis and its applications		6,7
	3.9	Genomic tools; ORF Finder, GenScan, Augustus		7
4	**4**	**Practicals**	**30**	
	4.1	Experiments using ORF Finder, GenScan, Augustus Lab, Variant Analysis, SNP Analysis, Gene Prediction Programs, Genome Annotation Tools, Swiss model modeling		5,6,7
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	
	MODE OF ASSESSMENT **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References:

1. Mount, D. W., & Harbor, S. (2006). *Bioinformatics : sequence and genome analysis*. Cold Spring Harbor Laboratory Press, [Post], Cop.
2. Lesk, A. M. (2017). Introduction to Bioinformatics (4th ed.). Oxford University Press.
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	Mahatma Gandhi University **Kottayam**					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Biostatistics**					
Type of Course	**DSE**					
Course Code	**MG4DSEBIF200**					
Course Level	**200-299**					
Course Summary & Justification	This course provides a comprehensive introduction to the principles of biostatistics with a focus on their application in Bioinformatics. After studying this course, students will learn statistical methods and techniques essential for the analysis and interpretation of biological and biomedical data.					
Semester	IV	Credits			4	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**60**
		3	1	0	0	
Pre-requisites	Idea in fundamentals of statistics					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1.	Able to apply bio-statistical techniques to design and analyze experiments and observational studies in the context of health and biological research	A	2,3,6,10
2.	Develop skills in creating effective visual representations of biometric data using graphs, charts, and other visualization techniques	S	3
3.	Understanding the principles of statistical inference to draw meaningful conclusions from biometric data sets	U	1,3
4.	Understanding the principles of experimental design, sampling methods, and statistical inference.	U	1,3
5.	Able to comprehend the concept of central tendency, including mean, median, and mode, and understand their applications in biostatistics	A	3
6.	Apply appropriate statistical methods to analyze biometric data, such as measures of central tendency, dispersion, and frequency distribution	A	2,3

7.	Mastery of fundamental probability calculations and understanding the concept of events, sample spaces, and conditional probability	U	1,3
8.	Evaluate probability to make predictions and draw conclusions about populations based on sample data	E	2,6
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Data collection and its presentation**	**15**	
	1.1	Biostatistics: history, definition, scope, aim and application of biostatistics. Role of Biostatistics in modern research		1
	1.2	Data collection: Primary and secondary data. Organization and classification of data, methods and objectives of classification of data, differences between classification and tabulation		2
	1.3	Data summarization and class interval. Preparation of class interval. Tally marks. Frequency distribution, types of frequency distribution. Working rules to prepare a frequency table		2
	1.4	Presentation of data: Tabular presentation and diagrammatic presentation: ,line diagrams, Bar diagrams, Pie charts , Pictograms , map diagrams		2
	1.5	Graphic presentation of data , types of graphs, histogram, frequency polygon, kite diagram, stem and leaf displays, frequency curve, cumulative frequency cursor ,Ogives , scatter or dot diagrams		2
2	**2.**	**Measures of Central Tendency, Measures of Dispersion**	**15**	
	2.1	Definition, Characteristics of central tendency or average. Types of measures of central tendency		5
	2.2	Arithmetic mean; simple, weighted and combined mean (Merits, demerits and simple problems). Median, mode, Geometric mean, Harmonic mean (Merits, demerits and simple problems)		5

	2.3	Partition values: Percentiles, Quartiles, Deciles (properties without proof and simple problems)		5
	2.4	Measure of dispersion: Definition; Range, Mean deviation, Quartile deviation, Standard deviation, variance, coefficient variation		6
3	**3**	**Probability, Distribution**	**15**	
	3.1	Basic concepts of probability, definition, types of probability, discrete and continuous probability distribution. classical and statistical, important terms		7
	3.2	Addition theorem (up to 3 events)		7
	3.3	Conditional probability, Multiplication theorem		7
	3.4	Probability rules and Bayes' theorem		7
	4.	**Statistical Inference and parametric tests**	**15**	4
	4.1	Concepts of parameter, Statistic and Sampling Distribution		4
	4.2	Estimation-Point and Interval Estimate of a Parameter, Standard errors		4
	4.3	Null and Alternative Hypotheses, Statistical Tests and Distributions, Concepts of Type I & II Errors, p- values		4
	4.4	Parametric tests: t-test, ANOVA and Chi-square testing		4
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars

	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

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5. An Introduction to Statistical Methods; Gupta C.B; Vikas Publishing House Pvt. Ltd. New Delhi; 23rd Revised Edition

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3. Introduction to Biostatistics and Research Methods; P.S.S Sundar Rao; Prentice-Hall of India Pvt. Ltd. New Delhi 2007, 4th Edition.
4. Biostatistics: A manual of Statistical Methods for Use in Health, Nutrition and Anthropology; K. Visweswara Rao; Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, 2007; 2nd Edition.
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	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Cellular Enzymology**
Type of Course	**DSE**
Course Code	**MG4DSEBIF201**
Course Level	**200-299**
Course Summary	The course focuses on the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell.

Semester	IV	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any	Understanding about enzymes and its functions					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate the basics of enzymes	U	1
2	Understand general properties of enzymes	K	1
3	Explain the mechanism of enzyme action	U	1
4	Articulate classification and factors affecting enzyme reaction	U	1
5	Understand different methods of enzyme regulation	U	1
6	List the applications of enzymes	K	2
7	Analyse cellular components and activity	An	2

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Enzymes and its cofactors**	15	
	1.1	Discovery, Introduction and history of enzymes: Contributions of Louis Pasteur and J B Sumner		1
	1.2	Properties of enzymes, enzymes as catalysts. Holoenzyme, apoenzyme, and prosthetic group		2
	1.3	Types of enzymes, Models for enzymes- substrate reaction: Models for mono substrate reaction (lock and key model and induced fit model). Models for bisubstrate reaction (Random sequential, ordered sequential and Ping-pong model		1
	1.4	Features of an active site. Ribozymes, Abzymes. Coenzymes: Coenzymes and their functions - NAD, NADP+ , FAD, FMN, TPP and biotin		4
2	**2**	**Enzyme kinetics**	15	
	2.1	Enzyme kinetics- Mechanism of Enzyme action (Transition state and activation energy).		5
	2.2	Order of reaction, Definition of IU, katals, enzyme turnover number.		3
	2.3	Factors affecting the velocity of enzyme catalyzed reaction- enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators.		4
	2.4	Introduction to Michaelis -Menten equation and LB plot.		5
	2.5	Inhibition of enzymatic reaction: Enzyme inhibition: Reversible and irreversible. Reversible- competitive, noncompetitive and uncompetitive inhibition- (double reciprocal plot and examples of each type).		3
3	**3**	**Enzyme regulation and application of enzymes**	15	
	3.1	Introduction to Enzyme regulation - covalently modulated enzymes , Adenylation, Phosphorylation		5
	3.2	Zymogen form of enzyme and zymogen activation		5
	3.3	Application of enzymes: diagnosis, therapeutics, drug development with special reference to personalized medicine, Gene therapy, Immunotherapy, Enzymes as drug targets		6
4	**4**	**Cellular biology**	15	

	4.1	Cell theory, structure of eukaryotic and prokaryotic cells, its components		7
	4.2	Cell cycle and cell death		7
	4.3	Membrane transport: passive (osmosis, simple and facilitated diffusion) & active (Na+-K+ pump, Ca+ pump and H+ pump		7
	4.4	Mode of membrane transport: Uniport, symport and antiport		7
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

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1. Trevor Palmer and Philip L. Bonner (2007). Enzymes- Biochemistry, Biotechnology, Clinical Chemistry Book , Second Edition, Woodhead Publishing, ISBN- 978-1-904275-27-5
2. T. Devasena (2010). Enzymology, Oxford University Press, 0198064438, 9780198064435.
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9. Cell and Molecular Biology- Gerald Karp 7th edition.
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	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Molecular Structures in Bioinformatics Perspective**
Type of Course	**DSC C**
Course Code	**MG4DSCBIF202**
Course Level	**200-299**
Course Summary & Justification	Understanding molecular structures from a bioinformatics perspective enables researchers to elucidate the relationships between structure and function, predict the effects of mutations, design new drugs, and understand the molecular basis of diseases.

Semester	III		Credits 4			Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**75**
		3	0	1		
Pre-requisites	Basic understanding about nucleic acid and protein sequences					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Appreciate the role of protein structure prediction techniques	Ap	1
2	Develop skills in using structural bioinformatics tools	S	2
3	Evaluate protein structures based on various criteria	An, A	1
4	Apply sequence analysis to predict nucleic acid structures	A	2,6
5	Apply sequence analysis to predict structure of complex molecules	A	2,6
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Protein structure analysis and prediction**	18	
	1.1	Gap between sequences and structures. Bottlenecks in structure determination		1
	1.2	Flexibility of protein backbone- Phi and Psi angles, steric hindrance. Ramachandran plot. Helical and Sheet propensities of amino acids		1
	1.3	Chou- Fasman method for secondary structure prediction. GOR method, ML-based methods		2
	1.4	Secondary Structure prediction tools- Jpred, PSSpred, PSIPRED. Applications of secondary structure prediction		2
	1.5	Knowledge based vs. Ab inito approaches. Concept of homology. Structurally conserved regions		2
	1.6	Homology modeling: template recognition, alignment, backbone generation, loop modeling, side chain modeling, optimization and validation.		2
	1.7	Fold recognition/ threading. Ab initio structure prediction. Critical assessment of protein structure prediction- CASP		2
	1.8	Tertiary Structure prediction tools- Modeller, Phyre2, ITASSER, AlphaFold2		2
	1.9	Protein structure validation; criteria for validation. Tools; ProCheck, What-If server.		2, 3
2	2	**Nucleic acid structure prediction**	12	
	2.1	RNA Secondary Structure Prediction: MFold and RNAfold		2, 4
	2.2	Tertiary Structure Prediction: 3DNA and RNAComposer		2, 4
3	**3**	**Complex carbohydrates and other molecules**	15	
	3.1	Structure prediction and analysis: Glycomics Tools: GlycoWorkbench and Glycan3D		2, 5
	3.2	Visualization Tools: Chimera		2, 5
4	**4**	**Practicals**	30	
	4.1	Secondary Structure Prediction Tools		2, 1,3
	4.2	Tertiary Structure Prediction		1,2,3
	4.3	Structure prediction of Nucleic acids using Bioinformatics tools		2, 4

	4.4	Complex molecular visualization		2, 5
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References:

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	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Basic Molecular and Microbial Techniques**
Type of Course	**SEC**
Course Code	**MG4SECBIF200**
Course Level	**200-299**
Course Summary	This course is designed to introduce you to general techniques used in molecular biology and microbiology as well as their application in research and industry.

Semester	IV	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0		45
Pre-requisites, if any	Interest in laboratory works and basic skills in handling equipments					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the safety measures taken in the laboratory	U	10
2	Analyze the general characteristics of an organism	A	1,10
3	Understand the cultural characters of different bacteria	U	1,10
4	Apply different molecular biology techniques for analyzing DNA, RNA, Protein	U	2
5	Apply the DNA amplification techniques	C	2

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Basic laboratory knowledge**	**10**	
	1.1	Laboratory safety measures: Good laboratory practices, good hygiene, storage methods, waste management		1
	1.3	Sterilization facilities and instruments		1

	1.4	Storage facilities: cold storage and deep freezing		1
2	**2**	**Microbial and molecular techniques**	**15**	
	2.1	Microscopy: Microscopic observation of living organisms. Wet mount, simple staining		2
	2.2	Microbial cultivation: culture methods. Cultural characteristics- colony characteristics, size, shape, color etc,		3
	2.3	Basic instrument: pH meter, vortex mixer, magnetic stirrer, weighing balance, centrifuge and other separation instruments (uses and demo only)		4
	2.4	Visualization equipment: UV transilluminator (uses and demo). PCR- introduction, principle, and demo of thermocycler		4
	2.5	Isolation of DNA & RNA: different sources. Steps in detailed		5
	2.6	Polymerase chain reaction: PCR- reagents, preparation of master mix		5
	2.7	Electrophoresis, difference between Tracking dye and loading dye, preparation of buffer, gel preparation for different purposes. Observation and interpretation of gel		4
3	**3**	**Tasks and techniques**	**20**	
	3.1	Identify the morphology of given organism using simple staining		3
	3.2	Observation of cultural characters of bacteria		3
	3.3	Differentiate motile and non-motile organisms		2
	3.4	Extraction of DNA/RNA		2
	3.5	Estimation of DNA/RNA from given sample (DPA)		5
	3.6	Extraction and estimation of protein (Lowry's /Biuret)		4
4	**4**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self learning, Practical demonstration.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks**

	Lab involvement/ Completion of tasks and techniques
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 3x5=20 marks) Long essay)2 out of 4; 2x10=20 marks)

References

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	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Health, Nutrition & Wellness**
Type of Course	**VAC**
Course Code	**MG4VACBIF200**
Course Level	**200-299**
Course Summary & Justification	To explore the relationship between nutrition and brain health, why it matters, and how to work towards positive food changes.

Semester	IV		Credits		3	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	45
		2	1	0	0	
Pre-requisites						

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate a comprehensive understanding of the key concepts in nutrition and health	U	**1,6,10**
2	Evaluate and analyze the nutritional content of different foods	E	**1**
3	Evaluate Nutrition Programmes	E	**1**
4	Evaluate the nutritional Aspects in Food	E	**3**
5	Understand Deficiency Diseases and Promote Healthy Lifestyle	U	**1,7**
6	Understand Specific Mental Health Disorders through Diet	E	**1,2,6**
7	Apply Nutritional Knowledge to Mental Health	A	**2,6,7**
8	Understanding the concept of Yoga and different streams of Yoga	U	**5,7**
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Foundations of Nutrition and Health**	**15**	
	1.1	Introduction to nutrition and health, concepts of nutrition, classification, protein, fat, carbohydrate, fiber, and vitamin, mineral and trace elements		1
	1.2	Functions of food: principal foods-cereals, pulses, vegetables, fruits, nuts, oil seeds, animal foods, milk and milk products, egg, fish, meat, drinks and spice		4
	1.3	BMR & factors affecting it		3
	1.4	Nutrigenomics and customized nutrition.		2
	1.5	National nutritional programmes: Vitamin A deficiency programme, National iodine deficiency disorders (IDD) programme, Mid-Day meal programme, Integrated child development scheme (ICDS)		3
2	2	**Nutritional Deficiency Diseases**	**15**	
	2.1	Major nutritional deficiency diseases: Protein Energy Malnutrition- their causes, symptoms, treatment, prevention		5
	2.2	Vitamin A deficiency - causes, symptoms, treatment		5
	2.3	Iron deficiency anemia- their causes, symptoms, treatment		5
	2.4	Iodine deficiency disorders- their causes, symptoms, treatment		5
	2.5	Lifestyle related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary/lifestyle modifications.		5
3	3	**Nutritional Psychiatry: Mental Health and yoga for Health**	**15**	
	3.1	Nutrition and Mental Health- Introduction to nutrients relevant to brain health		6
	3.2	Dietary patterns and mental health.		6,7
	3.3	The role of diet in relation to specific mental health problems (Depression, Schizophrenia, Dementia, Attention Deficit Hyperactivity Disorder (ADHD)		7
	3.4	Origin of Yoga, Meaning and Definition of Yoga, Scope and Objectives of Yoga		8
	3.5	Development of Yoga present day; Relevance and necessity of Yoga practices for healthy living		8

	3.6	Wellness through Yoga – attaining positive physical and mental health Yoga as a Way of Life to cope with Stress: Ahara, Vihara, Achara, Vichara and Vyavahara		8
4	**4**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Attending workshop/webinar on Yoga/ preparing diet plan for given disease/ any other tasks/Test paper
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks)

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1. Food Additives Characteristics, Detection &, Estimation by Mahindru S N (2000) Publisher: Tata Mcgraw, Hill Publishing, Co Ltd ISBN: 0074637355 ISBN-13: 9780074637357, 978-0074637357
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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) BIOINFORMATICS**				
Course Name	**Internship**				
Type of Course	**INT**				
Course Code	**MG4INTBIF200**				
Course Level					
Course Summary	This course provides students with a foundational understanding of the principles and concepts that form the basis of Bioinformatics				
Semester	**4**	Credits		**2**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
			-		2	30
Pre-requisites, if Any					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To understand the association of Bioinformatics with industry	**U**	1,2,10
2	To create and apply teamwork and leadership qualities among students and knowledge of real world problems	**A**	1, 2, 5,6
3	To perceive the role and responsibility of Bioinformatics in the industry.	**A**	5, 6
4	To assess the tools and techniques about bioinformatics	**An**	1,2,6,10

5	To network and collaborate with industry-professionals and ethical issues in the work environment.	**A**	7, 8, 9

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest(I) and Appreciation (Ap)

Mode of Assessment				
Sl No.	**Points**	**Distribution marks**	**Total Marks**	**Credit**
Internal evaluation				
1.	**Internal** Presentation of work	5	Internal marks -15	2
2.	Preparation of report	5		
3.	Attendance	2		
4.	Performance appraisal	3		
External evaluation				
1.	Final Report submission	10	External: 35	
2.	Attendance	5		
3.	Punchuality	5		
4.	Team work	5		
5.	Conduct	5		
6.	Completion certificate	5		

Semester V

	Mahatma Gandhi University, Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Perl & Bioperl Programming**
Type of Course	**DSC A**
Course Code	**MG5DSCBIF300**
Course Level	**300-399**
Course Summary & Justification	The course aims to introduce the basics of programming using the PERL language. Modules to familiarize the application of Bioperl are also included that will help students to process biological data using the programming language.

Semester	V	Credits			4	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**75**
		2	1	1	0	

Pre-requisites	Basic understanding of computer programming

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamentals of Perl and Bioperl Programming, including syntax, variables, data types and control structure	K	1
2	Understand conditional flow and looping constructs in Perl	U	1
3	Write and execute Perl scripts to solve real world problems	C	1,2
4	Understand regular expressions	U	1
5	Apply regular expressions in pattern matching	A	2
6	Learn the concept of subroutines and various built in functions	R	1
7	Create subroutines in Perl	C	2
8	Apply the programming concepts in Bioperl to solve problems in biology	A	2
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1.**	**The Perl Language**	14	
	1.1	Introduction, History, versions of Perl. Installing and setting up Perl, Writing and Running a Perl program		1
	1.2	Executing Perl Scripts-Command line and GUI		1
	1.3	Perl Editors, Advantages of Perl		1
	1.4	Perl data types: Scalars, Arrays, scalar variables, Array variables, Manipulation of array elements, Numbers, Strings		1
	1.5	Perl Operators: Arithematic, Assignment, Logic, Increment and decrement, operator precedence and associativity		1
	1.6	Controlling program flow: Conditional statements, Loops: for, while, do…while, until and foreach; breaking out of a loop and skipping an iteration		2
	1.7	Input and Output: Creating a file, closing a file, reading data from a file, writing data to a file. Managing files and directories		2
2	**2.**	**PERL REGULAR EXPRESSION AND FUNCTIONS**	16	
	2.1	Introduction to pattern matching, defining word boundaries, anchors		4
	2.2	Character set in regular expression, specifying range of characters, excluding some character, matching any character and other basic applications of regular expression		4
	2.3	Matching patterns to any strings: Modifying the pattern matching criteria, making the pattern match case insensitive		5
	2.4	Finding all occurrences of a pattern. Replacing a pattern		5
	2.5	Introduction to built-in functions in Perl, String handling functions		6
	2.6	Defining and calling subroutines: Passing values into and returning values from subroutines		6,7
	2.7	Perl modules. Advantages of Perl Modules		6,7
3	**3.**	**BIOPERL**	15	

	3.1	Introduction of Bioperl, Installation of Bioperl		8
	3.2	General Bioperl classes: Bio:Seq class: Sequence input sequence output, sequence manipulation		8
	3.3	Accessing Genbank using Bioperl		8
	3.4	Introduction to Align IO module and BLAST parsing		8
4	**4**	**Practicals**	**30**	
	4.1	**Any 10 Perl programs using** Arrays Conditional Statements Loops Regular Expressions File Handling Built-in Functions User-defined functions		2,4,6
	4.2	**Bioperl programs:** Accessing any biological databases Parsing Sequence data Accessing BLAST		7,8
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks**

	Lab examination: 25 Viva voce :5 Record: 5

References:

1. Wall, L. (1991). Programming Perl. O'Reilly Media.
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8. Stajich, J. E., Block, D., Boulez, K., Brenner, S. E., Chervitz, S. A., Dagdigian, C., ... Birney, E. (2002).
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	Mahatma Gandhi University **Kottayam**				
Programme	**BSc (Hons) BIOINFORMATICS**				
Course Name	**Systems and Synthetic Biology**				
Type of Course	**DSC A**				
Course Code	**MG5DSCBIF301**				
Course Level	**300-399**				
Course Summary & Justification	Systems and Synthetic Biology is an interdisciplinary course that combines engineering principles with biological systems to explore the principles, methodologies, and applications of these cutting-edge fields.				
Semester	V	Credits **4**			Total Hours:
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	**60**
		3	1	0	
Pre-requisites	Solid foundation in molecular biology and biochemistry is essential for grasping the advanced concepts presented in the Systems and Synthetic Biology course. Prior exposure to bioinformatics concepts could be advantageous				

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the principles of Systems Biology	K	1,3
2	Articulate the fundamental concepts of biological networks and emergent properties	U	1
3	Analyze and interpret Protein-Protein Interaction (PPI) Networks and Gene Networks	An	1,2
4	Apply flux analysis techniques in biological systems	A	2
5	Demonstrate an understanding of Synthetic Biology principles and methodologies	U	1

6	Evaluate the robustness of biological systems and understand the E-Cell Project	An	2
7	Understand principles of Bacterial Photography and understand the applications and challenges of the Bacterial Camera Project.	U	1,2
8	Critically assess applications of Green Fluorescent Protein (GFP) in Synthetic Biology.	An	2
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Fundamentals of Systems and Network Biology**	**18**	
	1.1	Systems Biology: Definition, history, goals, and applications.		1
	1.2	Basic concepts: Biological networks, feedback loops, and emergent properties		2
	1.3	Overview of Gene Control, Working of Genetic Switches		2
	1.4	The biochemical, genetic and the systems paradigm		2
	1.5	Understanding Biological Systems as Networks		2
	1.6	Representation of Biological Interactions, Protein-Protein Interaction (PPI) Networks		3
	1.7	Gene Networks and Regulatory Circuits		3
	1.8	Flux Analysis in Biological Systems		4
2	**2**	**Synthetic Biology Fundamentals**	**12**	
	2.1	Introduction to Synthetic Biology		5
	2.2	Definition and Goals		5
	2.3	Design Principles and Methodologies		5
	2.4	Robustness in Biological Systems		6
	2.5	E-Cell Project: Overview and Goals, Computational Models in E-Cell		6
3	**3**	**Bacterial Camera Project and Green Fluorescent Protein**	**15**	
	3.1	Bacterial Camera Project: Principles of Bacterial Photography		7
	3.2	Applications and Challenges of BCP		7,8
	3.3	Overview of Green Fluorescent Protein (GFP) Project		8

	3.4	Green Fluorescent Protein (GFP) as a Reporter		8
	3.5	Applications of GFP in Synthetic Biology		8
4	**4**	**Applications and Case Studies**	**15**	
	4.1	Synthetic Biology in Medicine		8
	4.2	Application in Drug Discovery and Development		8
	4.3	Environmental Applications of Systems and Synthetic Biology		5
	4.4	Ethical Considerations in Synthetic Biology		5
	4.5	Risks and Benefits of research in Synthetic Biology		5
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

REFERENCES

1. Uri Alon. (2007). *An introduction to systems biology : design principles of biological circuits*. Chapman & Hall/Crc.
2. Klipp, E., Wolfram Liebermeister, Christoph Wierling, Axel Kowald, & Al, E. (2016). *Systems biology : a textbook*. Wiley-Vch, Cop.
3. Kitano H. Systems biology: a brief overview. Science. 2002 Mar 1;295(5560):1662-4.

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4. https://www.ebi.ac.uk/training/online/courses/network-analysis-of-protein-interaction-data-an-introduction/types-of-biological-networks/
5. https://doi.org/10.3389/fmicb.2013.00211
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	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Evolutionary Biology and Molecular Phylogenetics**
Type of Course	**DSE**
Course Code	**MG5DSEBIF300**
Course Level	**300-399**
Course Summary	This course aims to equip students with theoretical and applied aspects of evolutionary biology and molecular phylogenetics.

Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any	Idea about evolution					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate the fundamental aspects and theories of evolution	U	1,10
2	Articulate basic terms in phylogenetics	U	1
3	Apply various algorithms for phylogenetic tree construction	A	1,3
4	Articulate different tools and softwares for phylogenetic tree construction	U	2
5	Apply different tools for phylogenetic analysis	An	2
6	Application of phylogenetics	A	2

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Evolutionary Biology**	12	
	1.1	Theory of molecular evolution, Oparin-Haldane theory, Urey miller experiment		1
	1.2	Darwin Theory Galapagos island, common descent, gradualism, Multiplication, Natural Selection, Survival of fittest, Examples of natural selection: moth and Darwin finches		1
	1.3	Outline of Evolution Convergent evolution, Divergent evolution, Coevolution		1
	1.4	Evidence of evolution Fossil record, homologous body structure, similarities in early development		1
2	2	**Introduction of Phylogenetic Tree**	15	
	2.1	Terminologies Branches, node, root, taxa, and types of trees -unrooted tree, rooted tree, bifurcating, multifurcating		1
	2.2	Tree representation method Cladogram, and Phylogram.Steps in Tree Construction Selection of sequences, construction of MSA.		2
	2.3	Distance based method- UPGMA, Neighbour Joining Method Least Square (LS)Method, Minimum Evolution Method,		3
	2.4	Character based method : Maximum Parsimony Method Finding maximum parsimony trees, Strategies of searching for MP trees ,Consensus Tree, Weighted Parsimony		3,4
	2.5	Maximum Likelihood Method Computational Procedure of ML methods, theoretical foundation of ML method, Protein likelihood methods,		3,4
	2.6	Software's for tree construction PHYLIP, PAUP, MEGA, PHYML, TREEEPUZZLE		5
3	**3**	**Estimating Evolutionary Distance**	13	
	3.1	Interior branch test Normal deviate (Z) Test Analytical method Bootstrap interior branch test		3,4

	3.2	Bootstrap tests Condensed tree		3,4
	3.3	Tests for topological Differences Minimum evolutionary tree ,ML and MP tree. Advantage and Disadvantage of different Tree building methods		3,4
4	**4**	**Application**	**20**	
	4.1	Application of phylogenetic in Medicine Epidemiology, drug resistance, vaccine development, Diagnostic tool, Personalized medicine, Host pathogen interaction. Disease Surveillance, Source Tracing, Vaccine Development, Antibiotic Resistance Monitoring, Diagnostic Tool		6
	4.2	Application of phylogenetic in Anthropology, Ancestral population studies, Genetic diversity, mitochondrial and Y-chromosomal		6
	4.3	Application of phylogenetic in Agriculture Crop Improvement, Biodiversity Conservation, Disease Resistance, Adaptation to climate change		6
	4.4	Application of phylogenetic in Drug Discovery Natural product discovery, Bio prospecting, metagenomics and microbiome studies, evolution of drug resistance, Target identification.		6
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

References

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3. https://mobot-biodiversity-jc.weebly.com/uploads/1/8/6/0/18603232/the_evolutionary_biology_of_species_by_t_g_barraclough_2019.pdf
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5. https://www.mimuw.edu.pl/~lukaskoz/teaching/sad2/books/Molecular-Evolution-and-Phylogenetics.pdf
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7. https://link.springer.com/article/10.1007/s00239-020-09982-w
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	Mahatma Gandhi University ,Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Soft Computing Techniques**
Type of Course	**DSE**
Course Code	**MG5DSEBIF301**
Course Level	**300-399**
Course Summary	In this course the students are introduced to the concepts about soft computing and different techniques in soft computing, fuzzy logic, Artificial Neural Networks and Evolutionary Computing Techniques. This course aims to foster the ability of students in designing and implementing soft computing-based solutions in Bioinformatics problems.

Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate the application of soft computing in Bioinformatics	**U**	1,3
2	Apply soft computing and dimensionality reduction techniques	A	2
3	Understand different Fuzzy sets and Fuzzy Logic	U	2
4	Interpret different Evolutionary computing techniques	S	3
5	Understand different pattern in Bioinformatics using soft computing techniques	U	2,3
6	Apply Evolutionary Computing techniques	A	2,3

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1	**Introduction to Soft Computing and ANN**	12	
	1.1	History, areas and biological motivation in Soft Computing		1
	1.2	Introduction to Artificial Intelligence		1
	1.3	Soft Computing Techniques in Bioinformatics		1
	1.4	Artificial Neural Networks: Features of ANNs, supervised and unsupervised networks, Perceptron: Multi –layer perceptron, Hidden Markov Models		2
	1.5	Relevance of Artificial Neural Network in Bioinformatics		2
2	**2.**	**Fuzzy Logic**	**18**	
	2.1	Fuzzy sets Overview		3
	2.2	Properties		3
	2.3	Membership functions		3
	2.4	Fuzzy operations		3
	2.5	Applications		3
3	**3**	**Evolutionary computing**	**15**	
	3.1	Evolutionary Algorithm		4,6
	3.2	Components of Evolutionary Algorithms		4,6
	3.3	Genetic Algorithms		4,6
	3.4	Evolutionary Programming		4,6
	3.5	Genetic Programming		4,6
4	**4**	**Pattern Recognition in Bioinformatics**	**15**	
	4.1	Clustering		5
	4.2	Dimensionality reduction		5
	4.3	Classification		5
	4.4	Feature Selection		2

	4.5	Application of Pattern Recognition in Bioinformatics		2
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

References

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2. Mrutyunjaya Panda, Sft Computing Concepts and Techniques, University Science Press
3. S.Rajasekaran, G. A. Vijayalakshami,” Neural Networks, Fuzzy Logic and Genetic
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5. N. P. Padhy ,”Artificial intelligence and Intelligent Systems”, Oxford University Press
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7. J.E.Smith Introduction to Evolutionary Computing, Springer

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Research Methods in Biological Sciences**
Type of Course	**DSE**
Course Code	**MG5DSEBIF302**
Course Level	**300-399**
Course Summary	This course provides a comprehensive introduction to research methodology, equipping students with the skills to create research questions, establish hypotheses, plan experiments, gather data, and present findings.

Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	60
		3	1	0	0	
Pre-requisites, if any	Interest in research and basic idea about the area					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate the principles of research	K	1,10
2	Formulate Research Questions and Hypotheses	U	1,2,10
3	Evaluate scientific literature critically	An	1,10
4	Create and evaluate experimental protocols	E	1,10
5	Develop effective scientific writing	A	4,10
6	Learn Effective Communication Techniques to Work Well in Research Teams	A	4,9,10

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.

1	1	**Foundations of Research Methodology**	12	
	1.1	Definition, Objectives, Characteristics of Research		1
	1.2	Types of Research: Applied, Basic, Descriptive, Experimental, Exploratory Research.		1
	1.3	Research Methods: Quantitative and Qualitative		1
	1.4	Socioeconomic significance and impact of research		1
	1.5	Characteristics of a good researcher		1
2	2	**Formulation of Research**	15	
	2.1	Research Problems- Defining research challenges, formulating research questions, and enumerating qualities of a good research problem		1
	2.2	Research Hypothesis- The function of hypothesis in scientific inquiry, categories of hypothesis		2
	2.3	Formulating testable hypothesis, Assessing hypotheses		2
	2.4	Components of an Experimental Protocol. Creating experiments to verify theories, Managing the variables		2
	2.5	Research ethics considerations		2
3	3	**Research Design**	18	
	3.1	Collection of Primary and secondary data, Quantitative and qualitative data, Sampling methods		1,2
	3.2	Organization and Representation of data, Data entry and coding, Data tabulation and frequency distribution		1,2
	3.3	Visualization of data - Charts and graphs, Tables and figures, Maps		3
	3.4	Data analysis by descriptive statistics, Inferential statistics, Hypothesis testing,		4
	3.5	Interpretation of Data, identifying patterns and trends, Communicating research findings		4
	4	**Scientific Writing and related tools**	15	
	4.1	Preparation of Review article and Research article		5
	4.2	Preparation and submission of a Research Proposal, Dissertation and Thesis for funding		5
	4.3	Proofreading and Types of publications Peer Review – Single, double-blind		5
	4.4	Basics of Reference Management Tools		5
	4.5	Plagiarism and its types		3,5,6

	4.6	Plagiarism software: Mendely, Zotero, End note software for referencing. Software for paper formatting -Latex/MS office		3,5,6
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning , Interactive lectures, exploration & self learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

References

1. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by John W. Creswell (2020)
2. Essential Research Methodology for Students and Researchers by M. E. Paul, L. Elder, and S. Machi (2016)
3. Business Research Methods by Donald R. Cooper and Pamela S. Schindler (2019)
4. Doing Quantitative Research: A Practical Guide by Louise Burke, Christine J. Collier, and Sheila R. Jago (2007)
5. Research Methodology: A New Indian Perspective by C.R. Kothari (2018)
6. Research Methodology in Social and Behavioral Sciences by P.B. Desai and S.S. Pathan (2009)

SUGGESTED READINGS

1. Cooper, D. R., & Schindler, P. S. (2014). Business research methods (12th ed.). McGraw-Hill/Irwin.
2. "A Practical Guide to Experimental Design in Biochemistry" by Robert H. Abeles (1982)
3. "Designing Experiments for Biochemical Research" by David S. Moore (2001)
4. "A Primer on Biochemical Methods" by Jennifer R. Turner, Randy D. Gardner, and James A. Mussell (2009)

	Mahatma Gandhi University **Kottayam**					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Unveiling Molecular Patterns Through Cheminformatics**					
Type of Course	**DSE**					
Course Code	**MG5DSEBIF303**					
Course Level	**300-399**					
Course Summary & Justification	This course is designed to provide students with a comprehensive understanding of the fundamental concepts and practical applications of cheminformatics. It plays a pivotal role in drug discovery, materials science, and other related fields					
Semester	**V**	Credits			**4**	Total Hours:
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**60**
		3	1	0	0	
Pre-requisites	Familiarity with chemical structures, functional groups, and chemical reactions. Basic computer skills, including file management, software installation, and data handling. Prior exposure to bioinformatics concepts could be advantageous					

COURSE OUTCOME (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic aspects of Cheminformatics	U	1
2	Draw chemical structures	A	1
3	Understand molecular descriptors and fingerprints to characterize and represent chemical structures effectively	A	1
4	Apply 2D and 3D drawing tools for drawing chemical structures	A	3
5	Develop skills in virtual screening	A	3
6	Understand Cheminformatics approaches to polypharmacology and network pharmacology	U	2,3
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	1	**Basics to Cheminformatics**	12	
	1.1	Overview of Cheminformatics		1
	1.2	History and Evolution of Cheminformatics		1
	1.3	Applications of Cheminformatics		1
	1.4	Introduction to Chemical Structure Databases		2
	1.5	Chemical Structure Databases (PubChem, Drug bank, KEGG, ChEMBL, ChemSpider)		2
2	2	**Representation of Molecules & Cheminformatics software**	12	
	2.1	Representation of Molecules and Chemical Reactions		3
	2.2	Basics of chemical structure representation.		4
	2.3	Structure representation: SMILES, InChI and molecular graphs		4
	2.4	Introduction to Cheminformatics software and tools.		6
	2.5	Cheminformatics software and tools: RDKit, Cheminformatics Toolkit, Open Babel		6
3	3	**Molecular descriptors and fingerprints**	18	
	3.1	molecular descriptors and its types		3
	3.2	Generation and application of molecular fingerprints		3
	3.3	Descriptors in Quantitative Structure-Activity Relationship (QSAR) studies		3
	3.4	Descriptors used for property prediction in QSAR		3
	3.5	Chemical Structure Drawing: 2D Drawing Tools: Chemsketch, Chemspider, ChemDraw		3,4
4	4	**Cheminformatics in Drug Discovery**	18	
	4.1	Drug discovery process and the role of cheminformatics		6
	4.2	Ligand-based drug design and virtual screening		5
	4.3	Structure-based drug design and molecular docking		6
	4.4	ADMET prediction in drug discovery		6
	4.5	Cheminformatics approaches to poly pharmacology and network pharmacology		6
5	5	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning , Interactive lectures, exploration & self learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

References

1. Johann Gasteiger, & Engel, T. (2006). *Chemoinformatics*. John Wiley & Sons.
2. Gasteiger, J. (2003). *Handbook of Chemoinformatics: From Data to Knowledge.* Germany: Wiley-VCH.
3. Leach, A. R., & Gillet, V. J. (2007). *An Introduction to Chemoinformatics*. Springer.
4. Bunin, B. A. (2010). *Chemoinformatics: Theory, Practice, and Products.* UK: Springer.
5. Bajorath, J. (2004). *Chemoinformatics: Concepts, Methods, and Tools for Drug Discovery.* USA: Humana Press.
6. Ekins, S. (2006). *Computer Applications in Pharmaceutical Research and Development.* Germany: Wiley.

Suggested reading

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doi: 10.1016/j.proeng.2012.06.156.

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Genetic Engineering**
Type of Course	**DSE**
Course Code	**MG5DSEBIF304**
Course Level	**300-399**
Course Summary	The course introduces different methods to manipulate the genetic material of organisms and the rationale of genetic manipulation of different living systems. This also introduces the applications of genetic engineering in diverse areas including medicine, agriculture and environment.

Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any	Basic idea about gene and its expression					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate genetic engineering techniques, including gene cloning, recombinant DNA technology, and gene editing	U	1
2	Apply genetic engineering principles to solve biological problems and address real-world challenges.	A	2,6
3	Understand the application of genetic engineering in medicine, gene therapy and personalized medicine	An	2,6
4	Evaluate the role of genetic engineering in agriculture, environment, including the development of genetically modified organisms (GMOs) and crop improvement.	E	2,6
5	Articulate ethical issues related to genetic engineering, including considerations of privacy, consent, and societal impacts.	E	6,7,8
6	Develop a curiosity for ongoing research in genetic engineering	Ap	1

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Introduction to Genetic Engineering**	12	
	1.1	Historical development, need, and scope of genetic engineering		1
	1.2	Basic genetic engineering process scheme, general overview of applications, overview of ethical considerations		1
2	**2**	**Methods of Genetic Engineering**	15	
	2.1	Commonly used host systems in genetic engineering (description and application of each host system): *E. coli*, *Bacillus subtilis*, yeast, mammalian cell lines, human cell lines, animal germ lines, *Agrobacterium*, plant.		1
	2.2	Commonly used techniques and tools in genetic engineering (fundamentals, and one example; and applications of each): Restriction Enzymes and DNA Ligase; Gateway Recombination Cloning Technology; Gene Silencing Methods; Gene Editing; Targeted Mutagenesis; Viral Vector-Mediated Gene Delivery - e.g., lambda bacteriophage, adenovirus; Somatic Cell Nuclear Transfer		1
	2.3	Overview of common methods of gene transfer (other than viral-mediated): description, advantages and applications		2
	2.4	Genetic engineering for overexpression of protein and gene knockouts		2,3
3	3	**Application in Medicine, Agriculture & Environment**	18	
	3.1	Gene Therapy: types, methods and applications, success stories		3
	3.2	Pharmacogenomics: Creation of genetically engineered cell lines and animal models for drug screening, drug testing, and for studying genes involved in drug response; Prospects of genetic engineering in personalized medicine		3
	3.3	Ethical implications and regulatory considerations		5
	3.4	Crop improvement strategies; ethical and regulatory considerations		4
	3.5	Genetically modified crops - current scenario in India and world		4

	3.6	Genetic engineering for bioremediation, bioaugmentation, soil health, carbon capture, and conservation genetics		4
4	**4**	**Advances in GE**	**15**	
	4.1	Synthetic organisms for novel functions		4
	4.2	Epigenome editing		6
	4.3	Bioinformatic tools in genetic engineering		6
	4.4	Organoids and 3D Bioprinting		6
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

References

1. Sandy B. Primrose, and Richard Twyman. (2013) Principles of Gene Manipulation and Genomics. Wiley-Blackwell
2. Jeremy W. Dale, Malcolm von Schantz, Nicholas Plant (2011) From Genes to Genomes: Concepts and Applications of DNA Technology. John Wiley & Sons
3. Mann, Rosanna (2018) Genetic Engineering and Biotechnology. Callisto Reference,
4. Dehlinger, Carolyn A. (2014) Molecular Biotechnology. Jones and Bartlett Publishers, Inc
5. Sarma, P.V.G.K., (2020) A Practical Textbook of Genetic Engineering in Bacteria. MJP Publishers

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7. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick. (2013) Molecular Biology of the Gene. Pearson
8. Dhavendra Kumar (2014) Genomic Medicine: Principles and Practice. OUP USA
9. Bernard R. Glick and Jack J. Pasternak (2002) Molecular Biotechnology: Principles and Applications of Recombinant DNA. American Society for Microbiology.

SUGGESTED READINGS

1. CRISPR: A Powerful Way to Change DNA by Catherine Chambers
2. Genentech: The Beginnings of Biotech by Sally Smith Hughes
3. The Gene: An Intimate History by Siddhartha Mukherjee
4. The Epigenetics Revolution: How Modern Biology is Rewriting Our Understanding of Genetics, Disease, and Inheritance by Nessa Carey
5. Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves by George M. Church and Ed Regis

	Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Introduction to R Programming**					
Type of Course	**SEC**					
Course Code	**MG5SECBIF300**					
Course Level	**300-399**					
Course Summary	The course covers basics of R, its syntax and control statements, and functionalities in data manipulation and data visualization.					
Semester	V	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		1	1	1	0	60
Pre-requisites, if any	Basic knowledge on computer programming					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the installation of R Programming Environment.	U	1
2	Articulate Data types in R for developing programs.	A	1,3
3	Apply different R Data Structures	A	2
4	Develop programming logic using R Packages.	E	2
5	Analyze the datasets using R programming capabilities.	S	2,3
6	Visualize Data using R Graph plotting	S	2,3
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**R programming and data structures**	12	
	1.1	R Introduction, R Studio and Installing Packages in R, R Reserved Words, Variables & Constants		1
	1.2	Basic Input Output Statements in R		2
	1.3	R Operators and Operator Precedence		1
	1.4	Decision making statements		1
	1.5	Loops and functions in R		1
	1.6	Data Structures, Strings and String operations using R, Vectors in R		3
	1.7	List operation using R, Data Frame manipulation using R, Matrices in R, Array Operations, Factors in R		3
2	**2.**	**Charts Creation and reading files in R**	18	
	2.1	R Plot Function, ggplot		4
	2.2	Dot Charts, Bar Plot, Box Plot		4
	2.3	Pie Charts, Scatter Plots and Line Charts		4
	2.4	Histograms, Three-Dimensional Plots		6
	2.5	File Reading and Writing: Reading excel, CSV and other files using R		5
	2.6	Sending Output to a file , R objects		5
3	**3**	**Practicals**	30	
	3.1	Download and install R-Programming environment and install basic packages using install.packages command in R.		1
	3.2	Write a program in R to get the input from the user and display the value		1
	3.3	Implement R-Loops with different examples		3
	3.4	Learn the basics of functions in R and implement with examples		3
	3.5	Implement data frames in R		3
	3.6	Implement different String Manipulation functions in R.		
	3.7	Implement different data structures in R		3
	3.8	Write a program to read a csv file and print the contents		6
	3.9	Create different Charts using R		6

	3.10	Plot different graphs using R		6
4	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 15 Marks** Test papers/Assignments/Report on Industrial visit **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 35 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (3 out of 5; 3x5=15 marks) Long essay)1 out of 3; 1x10=10 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

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1. Jared P. Lander, *R for Everyone: Advanced Analytics and Graphics,* 2nd Edition**,** Pearson Education, 2018.
2. S. R. Mani Sekhar and T. V. Suresh Kumar, *Programming with R,*1st Edition, CENGAGE, 2017.
3. Adler, J. (2010). R in a nutshell: A desktop quick reference. "O'Reilly Media, Inc.".
4. Gentleman, R. (2008). R programming for bioinformatics. CRC Press
5. Andrie de Vries , Joris Meys R Programming for Dummies, Wiley
6. Winston Chang R Graphics Cookbook: Practical Recipes for Visualizing Data 2nd Edition "O'Reilly Media, Inc.".

WEB REFERENCE:

1. https://www.r-project.org/

Semester VI

	Mahatma Gandhi University, Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Structural Bioinformatics**
Type of Course	**DSC A**
Course Code	**MG6DSCBIF300**
Course Level	**300-399**
Course Summary & Justification	This course aims to enhance students' understanding of 3D molecular interactions and life processes, enabling them to visualize biomolecules, analyze structural features, calculate physicochemical properties, and apply computational techniques.

Semester	VI	Credits 4				Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**75**
		2	1	1	0	
Pre-requisites	Basic understanding about the structure of biomolecules					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the importance of 3D structures in living systems	U	1
2	Understand and apply different features in molecular visualization tools	U, A	2
3	Appreciate the role of protein structure prediction techniques	Ap	1
4	Develop skills in using structural bioinformatics tools	S	2
5	Evaluate protein structures based on various criteria	An, A	1
6	Appreciate the role of bioinformatics in areas like drug design and vaccine design	Ap	2,6
7	Apply the knowledge in proteomics tools to predict structure and functions of proteins	A	2

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Three-dimensional basis of life & Molecular Visualization**	18	
	1.1	Overview, Protein-protein, protein-DNA and protein-ligand interactions in life.		1
	1.2	Diversity of protein structures. Sequence-structure, sequence-function relationships		3
	1.3	Approaches in structure determination; NMR, X-ray crystallography, cryo-electron microscopy		3
	1.4	Recap of Structure databases; PDB, PubChem and their features		3
	1.5	History of molecular visualization- Physical and mechanical models. Emergence of computer graphics. Rasmol		2
	1.6	Coloring schemes; CPK. Display styles; wireframe, ball and stick, space-fill, cartoon and surface		4
	1.7	Molecular surfaces- van der Waals surface, solvent accessible surface, electrostatic surface		4
	1.8	Molecular interactions- Hydrogen bonds, short contacts and other interactions		1
	1.9	Molecular Visualization tools- RasMol, Deep View and PyMol		2
2	**2**	**Protein secondary and tertiary structure Prediction**	18	
	2.1	Gap between sequences and structures. Bottlenecks in structure determination		4
	2.2	Flexibility of protein backbone- Phi and Psi angles, steric hindrance. Ramachandran plot. Helical and Sheet propensities of amino acids		5
	2.3	Chou- Fasman method for secondary structure prediction. GOR method, ML-based methods		5
	2.4	Secondary Structure prediction tools- Jpred, PSSpred, PSIPRED. Applications of secondary structure prediction		7
	2.5	Knowledge based vs. Ab inito approaches. Concept of homology. Structurally conserved regions		7
	2.6	Homology modeling: template recognition, alignment, backbone generation, loop modeling, side chain modeling, optimization and validation.		7
	2.7	Fold recognition/ threading. Ab initio structure prediction. Critical assessment of protein structure prediction- CASP		7

	2.8	Tertiary Structure prediction tools- Modeller, Phyre2, ITASSER, AlphaFold2		7
	2.9	Protein structure validation; criteria for validation. Tools; ProCheck, What-If server.		5,7
3	**3**	**Applied Structural Bioinformatics**	**18**	
	3.1	Functional annotations; Domain mapping, Structure homology and structural complementarity searches		7
	3.2	Tools for functional annotations: ProFunc, COFACTOR, FATCAT server.		7
	3.3	Drug design. Target based approach. Introduction to molecular docking		6
	3.4	Ligand based drug design; Structure activity relationships of small molecules. Introduction to QSAR		6
	3.5	Analysis of structural and functional effects of mutations, effects on drug binding.		7
	3.6	Vaccine design; protein-protein docking in predicting antigen antibody interactions.		6
	3.7	Protein structure redesigning, enzyme engineering		7
4	**4**	**Practicals**	**21**	
	4.1	PDB Database		2
	4.2	Molecular Visualization tools		2
	4.3	Secondary Structure Prediction Tools		3
	4.4	Tertiary Structure Prediction		4
	4.5	Molecular Docking tools		7
	46	Perform Phylogenetic analysis using PHYLIP & MEGA		2
	4.7	Perform Tree visualization software using TREEVIEW X		2
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References:

1. Bujnicki, J. M. (2008). *Prediction of Protein Structures, Functions, and Interactions*. John Wiley & Sons.
2. Functions, and Interactions. John Wiley & Sons Ltd.
3. G. E. Schulz and RH. Schirmer(2009),Principles of Protein Structure.Springer IK Books,
4. Carl-Ivar Brändén, & Tooze, J. (2009). *Introduction to protein structure*. Garland Pub.
5. Molecular Modelling for Beginners, Alan Hinchliffe, UMIST, Manchester,UK, John Wiley & Sons, Ltd.
6. Understanding Bioinformatics, Jeremy O. Baum, Marketa J. Zvelebil. 2007, Garland Science, USA S.C. Rastogi et al. Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery) Cavasotto, C. N. (Ed.). (2015).
7. In silico drug discovery and design: theory, methods, challenges,and applications. CRC Press.Sehgal, S. A., Mirza, A. H., Tahir, R. A., & Mir, A. (2018). Quick Guideline for Computational Drug Design. Bentham Science Publishers.

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Python Programming**
Type of Course	**DSC A**
Course Code	**MG6DSCBIF301**
Course Level	**300-399**
Course Summary & Justification	The course's goal is to give students basic Python programming skills so that they can write their own Python program to solve common biology problems.

Semester	VI		Credits		4	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	75
		2	1	1	0	
Pre-requisites	Basic Programming Knowledge					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic concepts in python	U	1
2	Create simple programs using python	C	1,10
3	Apply functions and files to improve the efficiency of the programs.	A	2
4	Develop models using numpy, matpolib	A	2
5	Understand the basics of Biopython	U	1
6	Apply File and Database Operations for Bioinformatics analysis	A	2
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate I, Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Programming with Python**	**15**	
	1.1	History, Features, Working with Python, Basic Syntax		1
	1.2	Variable and Data Types, Operator, Expression and Statements.		1
	1.3	Understanding the programming constructs with If , If- else, Nested if-else, For loop ,While loop ,Nested loops, Break ,Continue ,Pass		2
	1.4	Advanced programming in python: Function and methods, Recursion, Exception handling		3
	1.5	List: Traversing, List operation, list slices, list method, list and strings, Tuples: tuple assignment, tuple as a return type, list and tuples,Dictionary: Dictionary as a set of counters, Looping and dictionaries		3
2	2	**GUI**	**10**	
	2.1	Creating a GUI that handles an event using the tkinter package.		3
	2.2	Controlling layout with geometry manager pack, place and grid methods		3
	2.3	graphically visualizing the data using matplotlib package . Introduction of numpy package with different functions.		4
3	**3**	**BIOPYTHON**	**20**	
	3.1	Introduction to BioPython, History and Features		5
	3.2	Downloading and installing BioPython		5
	3.3	Application of Biopython in Bioinformatics and Computational Biology		5
	3.4	Sequence input output and basic sequence operations with Biopython, Alignments (Performing BLAST) with BioPython		5
	3.5	File and Database Operation , Reading and Writing to a file in Python		5

	3.6	Append Operations in File, Creating Database using SQLITE3, DML, DDL Commands using SQLITE3		5
4	**4**	**Practicals**	**30**	
	4.1	Program to demonstrate Basic Input Output Operations		1
	4.2	Program to demonstrate if statements		1,2
	4.3	Program to Demonstrate loops in Python		2
	4.4	Program to demonstrate List and Tuple in Python		3
	4.5	Program to demonstrate Dictionary in Python		3
	4.6	Program to demonstrate Functions in Python		3
	4.7	Program to Demonstrate GUI		3
	4.8	Programs to demonstrate Biopython		5
	4.9	Program to Demonstrate File Operations in Python		6
	4.10	Program to develop database using sqlite3		6
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks**

	Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References

1. Jason Kinser, “Python for Bioinformatics”, Jones & Bartlett Publishers, 2008.
2. Mark Lutz, “Learning Python”, 3rd edition, O'Reilly, 2007.
3. Alex Martelli, David Ascher, “Python cookbook”, O'Reilly, 2002.
4. Libeskind-Hadas, Ran, and Eliot Bush. Computing for biologists: Python programming and principles. Cambridge University Press, 2014
5. Tiago Antao. Bioinformatics with Python Cookbook: Use modern Python libraries and applications to solve real-world computational biology problems.Edition 3.Packt Publishing Limited.2022

	Mahatma Gandhi University,Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**NGS Data Analysis**
Type of Course	**DSE**
Course Code	**MG6DSEBIF300**
Course Level	**300-399**
Course Summary & Justification	This course offers the basic and applied NGS sequencing methods, data analysis processes, and the tools utilized for the assembly, mapping, and interpretation of NGS data. Throughout the program, students will be exposed to a wide array of NGS sequencing techniques, fostering a comprehensive knowledge base.

Semester	**VI**	Credits			**4**	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**60**
		3	1	0	0	
Pre-requisites	Basic understanding of molecular biology, genetics and computer Introductory knowledge of genomics					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Evaluate the transition to next (second)-generation sequencing platforms	A	1
2	Conduct a comparative analysis of third-generation sequencing technologies	An	1
3	Analyze output, accuracy, and error types across next generation sequencing technologies	An	2
4	Remember the key NGS technologies in Sequencing preparation.	R	1
5	Identify the sequencing preparation methods.	R	1
6	Understand NGS data formats	U	1,3
7	Comprehend the significance of NGS data sources.	U	1
8	Analyze the sequence quality.	A	2
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Introduction to Next-Generation Sequencing (NGS)**	12	
	1.1	Overview of First-generation Technologies		1
	1.2	Introduction to second generation Technologies, Pros and Cons of Second-generation Sequencing		1
	1.3	NGS Platforms: Roche 454, ABI SOLiD, Ion Torrent, Illumina		4
	1.4	Introduction to Third-generation Sequencing: PacBio, Oxford Nanopore. Advantages and Disadvantages of Third-generation Sequencing		2
	1.5	Comparative Analysis of Output and Accuracy. Error Types Across First, Second and Third-generation Sequencing Technologies		3
2	**2**	**Introduction to NGS Technologies and Sequencing Preparation**	15	
	2.1	NGS Technologies Overview: DNA-seq, RNA-seq,		4
	2.2	NGS Technologies Overview: ChIP-seq, Hi-C, Single Cell Sequencing		4
	2.3	Sequencing Preparation Methods: Sample Preparation Techniques for Different NGS Types.		5
	2.4	Adaptors, Indexing, Barcoding		6
	2.5	Library Preparation Methods: Bridge Amplification, Emulsion PCR		4
3	**3**	**NGS Data Formats & Pre-processing**	18	
	3.1	Data Formats Overview:FASTQ, Subreads, Nanopore Data, Single Cell Data		7
	3.2	NGS Data Sources:NCBI SRA, EBI-ENA, DDBJ-SRA, GEO		7
	3.3	Retrieval Using SRA Toolkit and Aspera Connect		7

	3.4	Sequence Quality Measures: Phred Quality Score, Quality Check Tools: FASTQC		8
	3.5	Pre-processing Tools: Trimmomatic, Fastx-toolkit		5,6
4	**4**	**NGS Data Analysis**	**15**	
	4.1	NGS Data Assembly: Overview Output Formats: Contigs, Scaffolds		6
	4.2	Assembly Quality Assessment Metrics: N50, Total Length, Number of Contigs/Scaffolds		8
	4.3	Mapping Overview: Principles Tools: BWA, Bowtie		8
	4.4	Mapping Output Formats: BAM, SAM		8
	4.5	Mapping Alignment Assessment Metrics: Number of Reads Mapped, Concordant Reads		8
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

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1.Dr. Michal Janitz. (2008), Next Generation Genome Sequencing:
Towards Personalized Medicine, Wiley.
2.Stuart M Brown. (2013), Next-Generation DNA Sequencing Informatics Cold Spring Harbor Laboratory Press.

3. Sara El-Metwally, Osama M. Ouda & Mohamed Helmy. (2014),
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Gaurav Sablok, Sunil Kumar, Saneyoshi Ueno, Jimmy Kuo & Claudio Varotto. (20I5), Advances in the Understanding of Biological Sciences Using Next Generation Sequencing (NGS) Approaches, Springer International Publishing.
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12. Wing-Kin Sung. (2020), Algorithms for Next-Generation Sequencing, Chapman and Hall/ CRC.

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Bioinformatics: An Applied Perspective**
Type of Course	**DSE**
Course Code	**MG6DSEBIF301**
Course Level	**300-399**
Course Summary	The course objectives are to provide students with training in creating and carrying out bioinformatics procedures as well as a general understanding of many important bioinformatics concepts and instruments that are frequently used in biology and molecular biology.

Semester	VI	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any	Basics of Bioinformatics and its techniques					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand major bioinformatics companies in India and Abroad	A	1,10
2	Understand the basics of combinatorial chemistry	U	1
3	Articulate IPR and its type in Bioinformatics	K	1
4	Explain the genomic level studies in bioinformatics	K	1

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Bioinformatics in India**	15	
	1.1	Survey of bioinformatics companies in India and abroad		1
	1.2	Commercial software in Bioinformatics		1
	1.3	Bioinformatics institutions in India		1
	1.4	Pharma industries		1
	1.5	Biomedical informatics		1
2	**2**	**Bioinformatics in health sector**	15	
	2.1	Genome wide association studies and its role in disease research. Disease - target gene relationship		1
	2.2	Comparative genomics approaches in target prediction		1
	2.3	Pharmacogenomics. Application of genomics in clinical research		2
	2.4	Advances in protein structure prediction an overview. Machine learning techniques for tertiary structure prediction		2
	2.5	Redesigning protein for useful purposes- Protein engineering		2
	2.6	Bioinformatics in drug repurposing. Peptide drugs and their prospects		2
3	**3**	**Structure and ontology prediction**	15	
	3.1	Comparative genomics in functional annotation		4
	3.2	Sequence based gene ontology predictions		4
	3.3	Structure based gene ontology predictions		4

	3.4	PPI network analysis for functional annotation		4
	3.5	Structure homology and structure complementarity analysis		4
4	**4**	**Advancement of Bioinformatics**	**15**	
	4.1	Bioinformatics in Personalized medicine		3,4
	4.2	Case studies on application of Bioinformatics in agriculture		3,4
	4.3	Case studies on role of Bioinformatics Phylogenetic studies		3,4
	4.4	Bioinformatics in characterizing gut microbiome		3,4
	4.5	Bioinformatics and neuroscience		3,4
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

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References:

1. Understanding Intellectual Property Law Paperback – 4 August 2011 by
2. Donald S. Chisum (Author), Tyler T. Ochoa (Author), Shubha Ghosh (Author), Mary LaFrance (Author)
3. Intellectual Property - Siva Vaidhyanathan
4. Lesk, A. M.,"Introduction to Bioinformatics", Oxford, UK: Oxford University Press, 2002.
5. Madhu Bala Priyadarshi, "Applications of Bioinformatics", Biotech article, 2014

6. Bioinformatics methods and applications - Dev Bukhsh Singh and Rajesh Kumar Bathak
7. Bioinformatics tools for pharmaceutical drug product Development –
8. by Vivek chavda, Krishnan Anand, and Vasso Apostolopoulos.

	Mahatma Gandhi University,Kottayam					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Viral Informatics**					
Type of Course	**DSE**					
Course Code	**MG6DSEBIF302**					
Course Level	**300-399**					
Course Summary & Justification	Viral informatics is a specialized field that combines principles from virology, bioinformatics, and computational biology to study and analyze viruses at the molecular level. This course provides a comprehensive overview of the tools, techniques, and methodologies used in viral informatics, with a focus on understanding viral structure, function, evolution, and interactions with host organisms.					
Semester	**VI**	Credits			**4**	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	60
		3	1	0	0	
Pre-requisites	Understanding of basic biological concepts, including cell structure, molecular biology, and genetics. Basic knowledge of virology, including viral structure, replication cycles, and classification of viruses.					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the Scope and Significance of Viral Informatics	K	1
2	Understand Bioinformatics Principles in Viral Studies	U	1
3	Apply Viral Databases for Data Retrieval and Analysis	A	2
4	Annotate Viral Genomes and Assess Their Importance	An	2
5	Evaluate Evolutionary Dynamics of Specific Viruses	An	2
6	Assess Antiviral Targets and Drug Discovery Strategies	An	1

7	Apply Viral Informatics in Epidemiological Studies	A	2,6
8	Evaluate Computational Vaccinology Approaches	E	1
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Introduction to Viral informatics**	12	
	1.1	Definition, Scope, and Significance. Integration of Bioinformatics in the Study of Viruses		1
	1.2	Viral Databases and Resources: Viral Genomic Databases (e.g., NCBI Viral Genomes, ViPR). Data Retrieval and Analysis		3
	1.3	Introduction to Viral Genome Sequencing Projects: Human Virome Project and Other Major Viral Genome Initiatives		2
	1.4	Viral Genome Annotation		4
	1.5	Importance of Viral Genome Analysis		7
2	**2**	**Evolutionary Analysis of Viruses**	15	
	2.1	Principles of Viral Evolution		5
	2.2	Mutation, Recombination, and Selection in viral evolution		5
	2.3	Case Studies on the Evolution of Specific Viruses: Influenza		6
	2.4	Evolution of HIV and SARS-CoV-2		6
	2.5	Co-evolution with hosts		7
3	**3**	**Antiviral Targets and Drug Discovery**	18	
	3.1	Introduction to Antiviral Targets		6
	3.2	Viral Enzymes and Structural Proteins		6
	3.3	Host-Virus Interactions		6
	3.4	Drug Discovery Strategies: Small Molecules, Protease Inhibitors, Nucleoside Analogues		6
	3.5	Challenges and Opportunities in Antiviral Drug Development		6
4	**4**	**Applied Viral informatics**	15	
	4.1	Application of Viral informatics in Epidemiology		7
	4.2	Outbreak Analysis, Contact Tracing Epidemiology study		7
	4.3	Introduction to Computational Vaccinology		8

	4.4	Prediction of Epitopes and Vaccine design		8
	4.5	Viral vectored Vaccine.		8
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

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2. 2021 by Chapman & Hall.
3. Darren R. Flower. Bioinformatics for Immunomics (Immunomics Reviews). \
4. New York: Springer-Verlag, 2010.

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1. Sanjay Kumar, Geethu S Kumar, Subhrangsu Sundar Maitra, Petr Malý, Shiv Bharadwaj,
2. Pradeep Sharma, Vivek Dhar Dwivedi, Viral informatics: bioinformatics-based solution for managing viral infections, *Briefings in Bioinformatics*, Volume 23, Issue 5, September 2022, bbac326, https://doi.org/10.1093/bib/bbac326
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5. Petrova, V., Russell, C. The evolution of seasonal influenza viruses.
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13. development, preventive and therapeutic applications in human diseases.
14. *Sig Transduct Target Ther* **8**, 149 (2023). https://doi.org/10.1038/s41392-023-01408-5

Website Reference

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2. https://www.ncbi.nlm.nih.gov/genome/viruses/

	Mahatma Gandhi University Kottayam					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Transcriptomics**					
Type of Course	**DSE**					
Course Code	**MG6DSEBIF303**					
Course Level	**300-399**					
Course Summary	The aim of the course is to provide a solid foundation in Transcriptomics as well as an introduction to informatics-based methods.					
Semester	VI	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate the basic concepts in Transcriptomics.	U	1
2	Understand various types of RNA's	A	1
3	Articulate the functions of Gene Regulation	U	1,10
4	Illustrate various transcriptomics approaches.	An	1
5	Describe various Bioinformatics Approach	U	1
6	Elucidate the use of transcriptomics in various domain	A	2
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Introduction to Transcriptomics**	15	
	1.1	Overview of gene expression, phases of gene expression :(Transcription,RNA processing, Translation),Components involved, Regulation,Importance		1
	1.2	What is transcriptomics, Historical perspective and emergence of transcriptomics		1
	1.3	Early discoveries, evolution of transcriptomics,		1
	1.4	Concept of transcriptomics		1
	1.5	Steps in Transcriptomics		1
2	**2**	**RNA world**	12	
	2.1	RNA ,FEATURES ,Types		2
	2.2	RNA modification and role in Diversity		2
	2.3	RNA sequencing technologies (Next Generation Sequencing)		2
	2.4	RNA library preparation		2
	2.5	Sequencing platforms		2
3	**3**	**Data analysis in Transcriptomics**	18	
	3.1	Quality controlling and preprocessing of RNA sequence data		4
	3.2	RNA sequence alignment, assembly and annotation		5
	3.3	quantification of gene expression		3
	3.4	Database GEO, Array express etc., data-file formats,		5

	3.5	Computational prediction miRNA genes and miRNA targets		5
	3.6	Bioinformatics of siRNA designing		5
	3.7	Integrating transcriptomics with other omics data (proteomics, genomics, metabolomics). Multi-omics data analysis and interpretation		4,6
4	**4**	**Applications of Transcriptomics**	**15**	
	4.1	Transcriptomics in structural and functional RNA		6
	4.2	Transcriptomics in drug design		4,6
	4.3	Transcriptomics in Human cancer hazard assessment		4,6
	4.4	Transcriptomics approaches in genetic disorders		4,6
	4.5	Impact of transcriptomics on Pharmaceutical Research.		4,6
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

Reference:

1. https://www.ualberta.ca/biological-sciences/media-library/mbsu/microarray/amersham-microarray-handbook.pdf

2. Transcriptomics and Gene Regulation-jiaqian
3. Biology Hardcover – Import, 5 January 2007 by Eldra P. Solomon (Author), Linda R. Berg (Author), Diana W. Martin (Author)
4. Transcriptome Analysis – Miroslav Blumenberg
5. Transcriptomics Expression Pattern Analysis -by Virendra Gomase

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Java Programming for Biologists**
Type of Course	**SEC**
Course Code	**MG6SECBIF300**
Course Level	**300-399**
Course Summary & Justification	The "Java Programming for Bioinformatics" course is meant to teach bioinformatics students about the computer language Java and how it can be used to solve problems in the field of bioinformatics. Hands-on experience with programming is emphasized in the course, with a focus on learning useful skills for using Java to analyze and change biology data.

Semester	VI	Credits			3	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	60
		1	1	1	0	
Pre-requisites	Basic Programming Knowledge					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand Object Oriented Programming concepts in Java Programming	U	1,3
2	Create Java application programs using proper program structuring.	A	2
3	Implement reusability concepts using inheritance, interfaces and packages	Ap	2
4	Apply exception handling mechanism and multitasking concept	A	2
5	Understand the string, stream & file classes	U	1
6	Create Java applications with graphical user interface (GUI).	C	2,3
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**An Introduction and overview of Java, objects and classes**	**15**	
	1.1	History & Features of Java, comparison of java & C++ Java Tools And Editors (Appletviewer,Jar,Jdb). Java Environment. Types of Comments. Built in Data Types, Variables and Constants		1
	1.2	Operators, Memory Allocation Using new Operators. Output using println() method, Control Statements, Arrays, Simple Java Programs		1,2
	1.3	Classes-concepts, methods & objects, using this keyword. Constructors-types, constructor overloading		2
	1.4	static variables and methods, access specifiers (private, protected and public), Garbage collection, finalize method. Methods & Packages- creating, accessing and using packages		2
2	**2**	**Inheritance, Interfaces, exception, strings and streams**	**15**	
	2.1	Basics and Types of Inheritance. use extends keyword, Super class, Subclass and use of Super Keyword. Method Overriding, Use of final keyword related to method and class, Use of Abstract class		3
	2.2	Implementation of interfaces. interface variables and interface methods		3
	2.3	Errors & exceptions, types of exception, exceptions handling using try and catch and throws keywords. uses finally block		4
	2.4	String class and String Buffer Class. Stream classes, Byte Stream classes, Character Stream Classes		5
	2.5	Using the File class, Creation of files, Reading/Writing characters and bytes, Handling primitive data types.		5
	2.6	GUI based I/O, Input and Message Dialog boxes. Swing components, Displaying text and images in the window.		6
3	**3**	**Practicals**	**30**	
	3.1	To find the average of two numbers.		6
	3.2	To find the area and circumference of a circle.		6

	3.3	To find the day of a week using switch case statements.		6
	3.4	To find the average of given numbers using a statement.		6
	3.5	To sort a given string.		6
	3.6	To demonstrate sample packages.		6
	3.7	To find the nature of the solution (pH concentration).		6
	3.8	To find the AT+GC content of a given DNA sequence.		6
4		**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning , Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 15 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 35 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (3 out of 5; 3x5=15 marks) Long essay)1 out of 3; 1x10=10 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

Reference Books:

1. Complete reference Java by Herbert Schildt (5th edition)
2. Java 2 programming black books, Steven Horlzner
3. Programming with Java, A primer ,Fourth edition , By E. Balagurusamy
4. Java servlet Programming by Jason Hunter, O'Reilly
5. Core Java Volume-I-Fundamentals, Eighth Edition, Cay S. Horstmann, Gary Cornell,
6. Prentice Hall, Sun Microsystems Press.

7. Core Java Volume-II-Advanced Features, Eighth Edition, Cay S. Horstmann, Gary Cornell, Prentice Hall, Sun Microsystems Press.

	Mahatma Gandhi University Kottayam					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Biosafety, Bioethics and IPR**					
Type of Course	**VAC**					
Course Code	**MG6VACBIF300**					
Course Level	**300-399**					
Course Summary	To provide a comprehensive understanding of the ethical, legal, and regulatory aspects associated with the field of biosafety and bioethics. It enable the students with knowledge about intellectual property rights and their implications in the biotechnology sector					
Semester	VI	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	1	0	0	45
Pre-requisites, if any	Basic ethical awareness					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	understand the concept of biosafety and its importance in scientific research and healthcare.	U, K	6,7
2	Acquire the knowledge and skills to identify and manage potential risks and hazards associated with biological materials.	S, E	10
3	Develop the ability to design and implement biosafety protocols and measures to ensure a safe working environment in laboratory settings.	A, An	3,6
4	Comply with national and international regulations and guidelines governing biosafety.	U, K	6
5	Identify and assess the potential risks associated with genetically modified organisms (GMOs) and their impact on human health and the environment.	U, An, A, E	2,6,7

6	Develop a comprehensive understanding of ethical principles and theories applicable to biological research and healthcare.	U, K	1,8
7	Demonstrate ethical conduct and decision-making in scientific research.	A, An, E	6,8
8	Understand the significance of intellectual property rights in the field of biosciences.	U, K	1,7
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1	**BIOSAFETY: GUIDELINES AND RISK ANALYSIS**	15	
	1.1	Introduction, biosafety issues; Biological Safety Cabinets & their types. Primary Containment for Biohazards		1
	1.2	Biosafety Levels of Specific Microorganisms. Biosafety guidelines and regulations (National and International); Regulatory bodies of India-RCGM and GEAC		2
	1.3	GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc		5
	1.4	Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication;		5
	1.5	Overview of International Agreements - Cartagena Protocol.		4
2	2	**INTRODUCTION TO BIOETHICS & ETHICAL PRINCIPLES IN BIOLOGICAL RESEARCH**	15	
	2.1	Overview of bioethics, ethical principles, such as autonomy, beneficence, non-maleficence, and justice		6
	2.2	Ethical Issues in Healthcare- such as end-of-life decisions, genetic testing, and resource allocation. ethical challenges related to patient autonomy, confidentiality, and access to healthcare		6
	2.3	Ethical Conduct in Scientific Research- importance of integrity, honesty, and transparency in scientific research		7
	2.4	Ethical considerations in AI driven bioinformatics research, privacy and security in handling genomic data.		7

3	3	**INTRODUCTION TO INTELLECTUAL PROPERTY**	15	
	3.1	Introduction to Intellectual Property and History. Patents, Trademarks, Copyright, Trade secrets, Trade dress, Industrial Design and Traditional Knowledge, Geographical Indications		8
	3.2	importance of IPR – patentable and non-patentable – patenting life		8
	3.3	legal protection of bioinformatics inventions – World Intellectual Property Rights Organization (WIPO),		8
	3.4	Types of patent applications: provisional and complete specifications		8
	3.5	An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement, Rights and Duties of patent owner. Basmati rice patent issue: a Case study.		8
	3.6	Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Cooperation Treaty (PCT); Indian Patent Act 1970 & recent amendments		8
4	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks)

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1. Narayanan, P. (2001). Intellectual Property Laws. Eastern Law House.
2. Paul, M. (2009). Intellectual Property Laws. Allahabad Law Agency.
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SUGGESTED READINGS

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2. Macklin, R. (2014). Bioethics, public moral argument, and social responsibility. Perspectives in Biology and Medicine, 57(1), 1-17.
3. Brown, T. A. (Year). Gene cloning: An Introduction. Chapman and Hall Pub.
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2. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
3. www.patentoffice.nic.in
4. www.iprlawindia.org/
5. http://www.cbd.int/biosafety/background.shtml
6. http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
7. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html
8. https://www.wipo.int/treaties/en/registration/budapest/

Semester VII

	Mahatma Gandhi University, Kottayam				
Programme	**BSc (Hons) BIOINFORMATICS**				
Course Name	**Pharmacogenomics & Personalized Medicine**				
Type of Course	**DCC**				
Course Code	**MG7DCCBIF400**				
Course Level	**400-499**				
Course Summary & Justification	In this course the students equip themselves with the genomic components associated with disease risk and drug response. They can analyze and establish relationships of mutations and other genetic factors with diseases and pharmacokinetics of drugs. The course is expected to generate an appreciation about the application of computational techniques in supplementing better and safer treatments, leading to Personalized Medicines.				
Semester	VII	Credits:		4	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	60
		3	1	0	0	
Pre-requisites	Basic understanding of bioinformatics				

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic concepts in Personalized Medicine	U	1
2	Understand the importance of genetic factors in disease risk and drug response	U	2
3	Analyze genomic sequences and identify variations	An, A	2
4	Explain the relationship between genomic variants and disease susceptibility	U, An	2
5	Evaluate the role of pharmacokinetics in determining treatment plan.	U, E	2
6	Understand the role of bioinformatics in personalized medicine	Ap	2
7	Apply the knowledge in pharmacogenomics to predict ideal drugs and dosage	A, C	2,6
8	Develop critical thinking and problem-solving skills	S	2

**Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Personalized Medicine- an introduction**	12	
	1.1	Effectiveness of drugs used in major diseases. Case study; Hypertension and cardiac drugs.		2
	1.2	Prevalence of ADRs associated with drugs used in major diseases. Case study; antibiotics		2
	1.3	Environmental factors affecting drug response, diet, concomitant drugs, concomitant diseases		2
	1.4	Genetic and Genomic components. Pharmacogenetics vs. Pharmacogenomics		3,4
	1.5	Personalized Medicine- definitions and major concepts. Objectives of PM		1
2	**2**	**Genes and Diseases**	15	
	2.1	Role of genes in diseases, Human genetic variations, Ethnicity and diseases		4
	2.2	Causes of variability: SNPs and their structural and functional consequences, copy number variations, role of repeats, chromosomal aberrations		3
	2.3	Genes and mutations associated with cancers. Case study: BRCA1		4
	2.4	Epigenomics of cancer		4
	2.5	Mitochondrial haplogroups and disease associations		4
3	**3**	**Pharmacogenomics (PGx) Basics**	18	
	3.1	Pharmacokinetics and Pharmacodynamics		5
	3.2	Absorption; oral bioavailability. Role of ABC transporters. Other routes of administration.		6

	3.3	Distribution: factors affecting drug distribution; logP, logS, ionization. Plasma protein binding and bioavailability. BBB permeability		6
	3.4	Biotransformation of drugs; consequences of metabolism. CYP450 isoenzymes and their roles. Other drug metabolizing enzymes		7
	3.5	Excretion of drugs; Role of transport proteins. Factors affecting elimination. Consequences of drug accumulation		7
	3.6	Target variability and drug action		7
4	**4**	**PGx in therapeutics and PM**	**15**	
	4.1	Role of NGS technologies in PGx. Gene expression analysis. Genome-wide association studies		7
	4.2	Personal genomics and implications		6
	4.3	Chemogenomics. Toxicogenomics. Pharmacovigilance		7
	4.4	Biomarkers- genetic markers, biochemical and diagnostic markers		4
	4.5	Early screening and genetic testing. Susceptibility prediction		7
	4.6	Drug and dosage selection. Prediction of ADRs. Redesigning improved drugs for patient subgroups.		7
	4.7	Genetic variants databases: dbVar, ClinVar, HGVD.		6
	4.8	Ethical issues related to personalized medicine		8
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks)

	Long essay)3 out of 5; 3x10=30 marks)

References:

1. Altman, R. B., Flockhart, D., & Goldstein, D. B. (Eds.). (2012). Principles of pharmacogenetics and pharmacogenomics. Cambridge University Press
2. Yan& Qing (2014). Pharmacogenomics in Drug Discovery and Development, Springer.
3. H. P. Rang, Drug Discovery and Development, Elsevier.
4. Lam, Y. W. F., & Scott, S. R. (Eds.). (2013). Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation. Academic Press.
5. Textbook of Drug Design and Discovery, Taylor & Francis.
6. Licinio, Wong; Pharmacogenomics: The Search for Individualized Therapies; Wiley
7. Richard, J.R. (2003). Analysis of Genes and Genomes. Wiley Publications.
8. Nadine Cohen; Pharmacogenomics and Personalized Medicine; Humana Press, 2010.
9. H. John Smith, Introduction to the Principles of Drug Design and Action, CRC Press.

	Mahatma Gandhi University **Kottayam**					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Molecular Modelling & CADD**					
Type of Course	**DCC**					
Course Code	**MG7DCCBIF401**					
Course Level	**400-499**					
Course Summary & Justification	This course aims to equip the students with computer assisted simulations like molecular docking and molecular dynamics to understand the binding affinity of lead molecules. Students will learn the computational approaches in designing drugs and predicting its biological activities.					
Semester	VII	Credits 4				Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**75**
		2	1	1	0	
Pre-requisites						

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic concepts in Molecular modeling	U	1
2	Understand various molecular mechanics terms	U	1
3	Understand the role of molecular simulations in drug development	Ap	2
4	Articulate the molecular basis of disease and drug action	R, U, An	1
5	Articulate steps in drug discovery pipeline	K, U	1
6	Understand the role of computers in rationalizing drug design	Ap	1,3
7	Apply the knowledge in molecular modeling and CADD to predict new lead compounds	A, C	2,3
8	Develop critical thinking and problem-solving skills	S	2

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Basics of Molecular modeling and simulations**	15	
	1.1	Molecular mechanics: components and definitions, coordinate system. Concept of energy, factors affecting energy. Potential energy surfaces, Global and local minimas		1
	1.2	Force fields, Parameterisation. CHARMM and Gromacs force fields. Energy minimization approaches: Steepest descent and conjugate gradient. Optimization of structure		2
	1.3	Molecular docking; Definitions and rationale. Lock and Key, Induced fit hypothesis. Terms associated with docking		2
	1.4	Search algorithms in docking; Genetic, Monte Carlo and simulated annealing algorithms		3
	1.5	Scoring functions in docking; Empirical scoring, knowledge-based scoring and force field scoring.		3
	1.6	Applications of docking. Docking tools: Autodock, SwissDock server.		4
	1.7	Molecular dynamics: Dynamic behavior of biological molecules, Objectives of dynamic simulations.		1
	1.8	Newtonian mechanics, Time scales, boundary conditions, trajectory. Applications of molecular dynamics.		4
2	**2**	**Disease and Drugs- basics**	15	
	2.1	Definitions of disease and drugs, Types of diseases		4
	2.2	Molecular basis of diseases. Concept of targets.		5,6
	2.3	Different classes of targets. Importance of GPCRs		5,6
	2.4	Case studies: EGFR as a target, COX2 as a target, HIV protease as target.		6
	2.5	Characteristics of drugs, mechanisms of action of drugs. Case study; Aspirin.		6
	2.6	Drug- receptor interactions		6
	3	**Computational Drug Discovery**	**15**	

3	3.1	Traditional drug discovery. Role of serendipity. Emergence of rational drug design. Challenges in drug discovery		6
	3.2	Drug discovery pipeline; Target identification and validation		5
	3.3	Lead identification: HTS; advantages and disadvantages. Lead optimization, animal trails and clinical trials		5
	3.4	Target prediction and validation approaches. Characterization of active site and active site predictions		7
	3.5	Structure based vs. ligand based approaches (SBDD vs. LBDD). SBDD: Virtual screening. Combinatorial libraries for drug design. Tools used for virtual screening. De-novo drug design and Pharmacophore		7
	3.6	LBDD: Ligand based virtual screening and pharmacophore. QSAR; molecular descriptors. COMFA		7
	3.7	Tools and Databases: DrugBank, KEGG ligand, GOLD. Lead optimization. ADME predictions		7
4	**4**	**Practicals**	**30**	
	4.1	CHARMM and Gromacs force fields		7
	4.2	Molecular Docking Tools		8
	4.3	KEGG Database		7
	4.4	SBDD tools		8
	4.5	ADME		7
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	
	MODE OF ASSESSMENT **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks**

	Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References:

1. Rastogi et. al., Bioinformatics: Methods and Applications, Prentice Hall of India.
2. Lesk, A. M. (2017). Introduction to Bioinformatics (4th ed.). Oxford University Press.
3. H. P. Rang, Drug Discovery and Development, Elsevier..
4. Thomas J Perun and C. L. Propst, Computer-Aided Drug Design: Methods and Applications
5. Textbook of Drug Design and Discovery, Taylor & Francis.
6. S.C. Rastogi et al. Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery)
7. Thomas J Perun and C. L. Propst, Computer-Aided Drug Design: Methods and Applications,
8. V. Kothekar, Essentials of Drug Designing, Dhruv Publications.
9. H. John Smith, Introduction to the Principles of Drug Design and Action, CRC Press.

	Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Immunoinformatics & Vaccine design**					
Type of Course	**DCC**					
Course Code	**MG7DCCBIF402**					
Course Level	**400-499**					
Course Summary	The course focuses on an overview of the immune system and how various immune system components are integrated during the response to infectious agents. It also highlights various computational methods and resources for understanding the mechanisms					
Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any	Understanding about immunology					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate different types of immunity	U	1
2	Understand role of immune response in antigenic determinant	U	1
3	Articulate antigen antibody reactions	K	1
4	Acquire basic skills in immunological assay techniques	An	2
5	Acquire a broad understanding of immune system malfunctioning.	U	1
6	Apply Bioinformatics tools in Immunology research	U,A	2,3
7	Create basic knowledge about new approaches to vaccine production	U	1

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Immune system and immunity**	15	
	1.1	Overview of immunology, Types of Immunity: Innate and acquired immunity		1
	1.2	Cells and organs of immune system		1
	1.3	Types and source of infection		1
	1.4	Antigens: Types, B cell and T cell epitope		2
	1.5	Antigen processing and presentation. B cell and T cell activation		3
2	**2**	**Antibody**	15	
	2.1	Basic Structure		3
	2.2	Immunoglobulin classes and their functions		3
	2.3	Generation of antibody diversity		3
	2.4	Antigen antibody reactions		3
3	**3**	**Clinical Immunology**	15	
	3.1	Hypersensitivity – Immediate and delayed reactions, Clinical types of hypersensitivity- Combs classification		5
	3.2	Auto immunity, Mechanisms of autoimmunization, Types of autoimmune disorders		5
	3.3	Immunodeficiency diseases.- Primary & Secondary immunodeficiency disorders		5
	3.4	Tumor immunology, Tumor antigens ,Immune response in malignancy,		5
	3.5	Immune hematology		5
4	**4**	**Immunoinformatics**	15	
	4.1	Principles of B-cell and T-cell epitope prediction		2
	4.2	B and T cell epitope mapping tools		2
	4.3	Allergenicity prediction.		4,6
	4.4	Vaccine : types, vaccine design, Reverse vaccinology		7
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

References

1. Essential Immunology - Ivan M. Roitt and Peter J delves, Blackwell Publishing.
2. Immunology - Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, and Janis Kuby, W H Freeman and Co.
3. Immunobiology - Charles A. Janeway Jr., Paul Travers, Mark Walport and Mark J. Shlomchik, Garland Publishing.
4. Essential Clinical Immunology – Helen Chappel and Mansel Haeney, ELBS/Blackwell Scientific Publications.
5. Introduction to Immunology – John W, Kimball Maxwell, Mac Millan International Edition.
6. Textbook of Microbiology – R. Ananthanarayanan and C K Jayaram Panicker. Orient Longman
7. Introduction to immunology- John W Kimball Maxwell.
8. Immunoinformatics predicting Immunogenicity in Silico- Daren R. Flower.

	Mahatma Gandhi University **Kottayam**					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Genomic Reconstitution Techniques**					
Type of Course	**DCE**					
Course Code	**MG7DCEBIF400**					
Course Level	**400-499**					
Course Summary	This course provides theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants.					
Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any	Understanding about biomolecules and its functions					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate techniques in recombinant DNA technology	K	1
2	Design designing and conducting experiments involving genetic manipulation.	C	2
3	Learner will know about different tools used for Genetic Engineering	U	1
4	Understanding in strategizing research methodologies employing genetic engineering techniques	U	1
5	Explain the application of recombinant DNA technology in biotechnological research	U	2
6	Apply the idea of molecular markers in finding solutions to different issues	A	2
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Introduction to recombinant DNA technology**	10	
	1.1	History of rDNA technology		1
	1.2	Cohen & Boyer's contribution		1
	1.3	Tools: Exonucleases, Endonucleases and its classifications		3
	1.4	Other enzymes: Kinases, Phosphatases, Site specific recombinases, topoisomerases, Ligases and Terminal Transferases		3
	1.5	Adapters and linkers		2
2	**2**	**Gene transfer and molecular markers**	16	
	2.1	Plasmids and their desirable properties, Eg: E coli-based vectors pBR 322. Shuttle Vector		2
	2.2	Bacteriophage vector eg: M13/ λ		2
	2.3	Vectors for Yeast (Any one example)		2
	2.4	Artificial Chromosomes- BAC, AC. Viral vectors (any one example).		4
	2.5	Gene transfer techniques in plants and animals: Agrobacterium mediated, particle gun delivery, Electroporation Liposomes mediated and microinjection		4
	2.6	Introduction and general uses of Molecular Markers: RFLP, RAPD, AFLP, VNTR, SNP, and advanced molecular markers		4
3	**3**	**Molecular techniques**	18	
	3.1	Commonly used techniques: Blotting techniques: Southern, Northern, Southwestern. PCR types and applications. DNA footprinting, fingerprinting, gel shift analysis, DNA microarray		4
	3.2	Chemical synthesis of DNA		4

	3.3	DNA sequencing- Maxam and gilbert, Sanger method, pyrosequencing, new generation sequencing.		4
	3.4	Site directed Mutagenesis: methods.		6
	3.5	Introduction to gene editing tools: Meganucleases, zinc finger nucleases (ZFNs), transcription activator-like effector-based nucleases (TALEN) and clustered regularly interspaced short palindromic repeats (CRISPR/Cas 9) system		6
4	**4**	**Applications of rDNA technology**	**16**	
	4.1	Agriculture: Metabolite engineering. Imparting new agronomic traits to plants to improve quality and quantity.		5
	4.2	Medicine: Production of small biomolecules: vitamin-C, amino acids. Production of r-insulin, Hepatitis-B virus vaccine. Marshalling recombinant DNA to fight AIDS. Gene therapy, Recombinant vaccines, Monoclonal antibodies.		5
	4.3	Industry: Biopolymers production (bioplastics), biofuel production (biodiesel), bioethanol production.		5
	4.4	Environment: Bioindicator organism		5
	4.5	R & D: model organism and protein engineering		5
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

.

References

1. B. R. Glick., et al. Molecular Biotechnology: Principles & Applications of Recombinant DNA (ASM Press, ed. 4, 2009).

2. S. B. Primrose, R. Twyman. Principles of Gene Manipulation and Genomics (Wiley-Blackwell, ed. 7, 2006)
3. . Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.
4. Genetic Engineering: An introduction to Gene analysis and exploitation in eukaryotes. Kingsman and Kingsman (1998) Blackwell Scientific Publication, Oxford.
5. DNA cloning: A Practical Approach. Glover and Hames (2001) Oxford University Press.
6. Gene Cloning and DNA Analysis: An Introduction, 6th Edition, T. A. Brown, Wiley-Blackwel 2. Principles of Gene Manipulation & Genomics – 7th Edition – Sandy B. Primrose, Richard Twyman– Blackwel

SUGGESTED READINGS

1. https://www.slideshare.net/VikasVerma268/genome-editing-techniques
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5131771/

	Mahatma Gandhi University Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Nanobiotechnology**
Type of Course	**DCE**
Course Code	**MG7DCEBIF401**
Course Level	**400-499**
Course Summary	This course gives an overview of the multidisciplinary topic of nanobiotechnology, which equip the students to solve biological problems.

Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any	Understanding the concepts of nano molecules and its application in biotechnology					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate fundamental properties of nanoscale materials	K	1
2	Understand the convergence of nanotechnology and biotechnology	An	1,3
3	Analyze interactions between nanoparticles and biological systems	An	2,3
4	Analyze the impact of biomimicry in the development of bioinspired nanotechnologies	E	2,3
5	Develop computational approaches to study Nano biological interactions	E	2,3

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Introduction to Nanotechnology**	**16**	
	1.1	Definition and principles of nanotechnology		1
	1.2	Historical development and milestones in nanotechnology		1
	1.3	Nanoscale materials and their properties		1
	1.4	Synthesis of nanoscale materials		1
	1.5	Fabrication and applications of nanocomposite materials		2
	1.6	Role of Nanomaterials in Nanobiotechnology		3
2	**2.**	**Convergence of Nanotechnology and Biotechnology**	**14**	
	2.1	Define interdisciplinary research and its significance in nanobiotechnology		3
	2.2	Nanoparticles and their interactions with biological systems		3
	2.3	Biomimicry and bioinspired nanotechnology		4
	2.4	Challenges and opportunities at the interface of nanotechnology and biology		4
	2.5	Potential for personalized medicine and targeted drug delivery		5
3	**3**	**Techniques and application of Nanobiotechnology**	**16**	
	3.1	Imaging techniques at the nanoscale (AFM, TEM, SEM, XRD, UV spectroscopy, DLS and Zeta Potential etc.)		5
	3.2	Nanoparticle synthesis and characterization: Physical, chemical and biological methods		3
	3.3	Drug delivery systems and nanomedicine		5
	3.4	Nanobiotechnology in Diagnostic medicine (diagnostics, imaging)		5
	3.5	Nanobiotechnology in therapeutics (nanomedicine, cancer therapy targeted drug delivery)		5
	3.6	Nanobiotechnology in environmental science, agriculture and food industry, forensic medicine		5
	4	**Bioinformatics in Nanobiotechnology**	**14**	

4	4.1	Data management and analysis in nanobiotechnology		5
	4.2	Computational approaches to study nano biological interactions		5
	4.3	Integration of bioinformatics tools in nanobiotechnology research		5
	4.4	Ethical issues in nanobiotechnology research, Regulatory framework for nanobiotechnology applications, Environmental and safety concerns.		5
	4.5	Current challenges and future perspectives of nanobiotechnology, Integration of artificial intelligence in nanobiotechnology research.		5
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

REFERENCES:

1. "Introduction to Nanotechnology" by Charles P. Poole Jr. and Frank J. Owens.
2. "Nanomaterials: Synthesis, Properties, and Applications" by A. S. Edelstein and R. C. Cammarata.
3. Scientific papers and articles on nanoscale material properties and applications in nanobiotechnology.
4. Nanobiotechnology: Concepts, Applications and Perspectives" by Christof M. Niemeyer and Chad A. Mirkin.
5. "Nanomedicine and Drug Delivery: Advances in Nanobiotechnology and Nanomedicine" by Melgardt M. de Villiers, et al.
6. Basic concept of Bioinformatics and Nanobiotechnology, by Mohammad Nadeem Khan, Lambert Academic publishing.
7. Role of Bioinformatics in Nanotechnology: An Initiation towards Personalized Medicine, Harishchander Anandaram

WEB REFERENCE:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6982820/

2. https://www.nano.gov/about-nanotechnology/applications-nanotechnology
3. https://www.frontiersin.org/articles/10.3389/fmedt.2022.1067144/full
4. https://www.sciencedirect.com/science/article/abs/pii/S0958166923001532
5. https://www.hindawi.com/journals/jnm/2021/4927607/
6. https://www.azonano.com/article.aspx?ArticleID=6063

	Mahatma Gandhi University Kottayam
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Knowledge Discovery from Biological Data**
Type of Course	**DCE**
Course Code	**MG7DCEBIF402**
Course Level	**400-499**
Course Summary	This course gives an overview of the multidisciplinary topic of data mining. Course analyzes different Data mining techniques and its application in Bioinformatics and Biological Data. It helps to learn various mining techniques used to analyses huge biological data to find the hidden patterns

Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	1	0	0	60
Pre-requisites, if any	Knowledge about biological data and its analysis					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate the basic concepts in data mining	K	1
2	Apply appropriate data mining methods in biological data analysis	U	2
3	Understand different learning strategies to integrate heterogeneous types of biological data	An	2,3
4	Understand the uses and limitations of data mining algorithms	U	1
5	Apply different data mining algorithms for huge heterogeneous biological data sets	E	2
6	Articulate different strategies for preprocessing, integrating and visualizing different types of biological data	S	1,3

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1	**Introduction to Data mining**	16	
	1.1	Introduction: Introduction – History - Importance of Data Mining		1
	1.2	Types of data gathered - Uses of Data Mining - Data Mining Techniques		2
	1.3	Data Warehouses -Transactional Databases - Advanced Database Systems and Applications		2
	1.4	Data Mining Architecture - Data Mining Functionalities - Classification of Data Mining Systems		2
	1.5	Major issues in Data Mining		2
	1.6	Data Mining Applications in Bioinformatics - Advantages and Disadvantages		5
2	2	**Classification, Prediction and clustering**	16	
	2.1	Classification and Prediction – Issues in Data preparation for classification and Prediction		3
	2.2	Classification by algorithms, Decision Tree Induction , Naïve Bayes, Backpropagation		5
	2.3	Clustering Methods: Clustering Analysis - Types of data in clustering analysis: Scaled variable, Binary variables		4
	2.4	Variables of Mixed Types - Partitioning Methods: K-means and K-Medoids - Model-Based Methods - Data Mining Applications		5
	2.5	Data mining for Biomedical and DNA Data Analysis		6
3	3	**Applications of Data mining**	14	
	3.1	Data Understanding and Preparation		5
	3.2	Anomaly Detection		6
	3.3	Gene expression Data mining, Gene mapping for disease detection		6
	3.4	Ontologies and vocabularies and examples of ontologies		6
	3.5	Disease ontology		6
	4	**Data Classification and Machine Learning**	14	
	4.1	Introduction to machine learning		6
	4.2	Mining text data using Rule based approaches		6

4	4.3	Mining text data using machine learning approaches		6
	4.4	Introduction to Deep Learning		6
	4.5	Evaluation and validation of data mining result		6
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

REFERENCES:

1. "Pang-Ning Tan, Michael Steinbach and Vipin Kumar, 2016, Introduction to Data Mining, Pearson India Education Services
2. Introduction to Data Mining. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, Addison Wesley.
3. Len Trigg et al, 2010, Weka-A Machine Learning Workbench for Data Mining
4. Sumeet Dua, Pradeep Chowriappa. 2012. Data Mining for Bioinformatics.
5. Data Mining Concepts and Techniques –, Academic Press Morgan Kaufman Publishers
6. Data Mining in Bioinformatics by Xindong Wu et.al, Springer

Semester VIII

MGU-UGP (HONOURS)

Syllabus

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**PHP Programming for handling Bioinformatics dataset**
Type of Course	**DCC**
Course Code	**MG8DCCBIF400**
Course Level	**400-499**
Course Summary	This course equips the student to develop any bioinformatics related online tools. At the end of the course student will be able to handle different bioinformatics data sets using MySQL and Data Manipulations using PHP programming

Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	1	1	0	75
Pre-requisites, if any	Basic knowledge about programming in computers					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the general concepts of PHP language for the development of bioinformatics online applications	K	1
2	Understand the general concepts of file handling using PHP	An	1
3	Understand the general concepts of Java Script	U	1
4	Apply the functions of MySQL and how to manage bioinformatics databases	A	2,3
5	Understand different frameworks and semantic web	U	1
6	Create different bioinformatics analytical tools using PHP and MySQL	S	2,3

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Introduction to PHP programming and Forms**	15	
	1.1	Introduction, Variables, echo, Print, Data types, string, Constants, Operators, Functions, Arrays		1
	1.2	Object Oriented Programs using PHP -Creating classes, accessing class Members in different Pages, Inheritance		1
	1.3	Form Handling, form Validation, form validation, form required, From Complete, Date and time, Cookies & sessions		3
	1.4	File handling and uploading in PHP		2
	1.5	Sending EMail		2
2	**2.**	**PHP MyAdmin**	15	
	2.1	Database Management in PHP MyAdmin(Create Drop Rename)		4
	2.2	Table Management (Create, Drop, Rename, Primary Key, auto Increment, Default variable, Null)		4
	2.3	Querry (Select, Insert, Update, Delete)		4
	2.4	Import and export database		4
	2.5	Connecting MySQL from PHP(mysqli_connect, Mysqli_Querry(Select, Insert, Update, Delete, Limit data), mysql_close		4
3	**3**	**Introduction to PHP Framework**	15	
	3.1	Introduction To MVC Architecture		5
	3.2	Laravel- Basic Features, Creating Projects using Laravel		5
	3.3	Semantic Web: RAP: RDF API For PHP		5
	3.4	Introduction to Web Hosting: host a project on a server		5
	3.5	Introduction To MVC Architecture		5
4	**4**	**Practicals**	30	
	4.1	Write a programme to count GC contents in the sequence		6
	4.2	Write a programme to find pattern		6
	4.3	Write a programme to check the location of Start Codon in the sequence		6

	4.4	Write a programme to demonstrate constructor and destructor		6
	4.5	Write a programme to demonstrate inheritance		6
	4.6	Write a programme to illustrate if statement		6
	4.7	Write a programme to illustrate loop statement-for,while		6
	4.8	Illustrate how to import any CSV file to database		6
	4.9	Illustrate how to Export as CSV from database		6
	4.10	Develop a PHP programme to create a database and a table		6
	4.11	Develop a PHP programme to insert ,delete and update values in to table		6
	4.12	Write a programme to demonstrate working of AJAX		6
	4.13	Write a program to demonstrate LAREVAL		6
5	**Teacher specific contents**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks)

	Practical: 35 Marks Lab examination: 25 Viva voce :5 Record: 5

References

1. Web Programming, Chris Bates, 3rd Edition; Pub: John Wiley & Sons
2. The complete reference PHP, Holzner; 1st Edition McGraw Hill Education,
3. https://github.com/PHPMailer/PHPMailer
4. Official Laravel Documentation https://laravel.com/docs/7.x
5. https://www.phptpoint.com/laravel-tutorial/
6. https://www.tutorialandexample.com/creating-first-laravel-project/
7. http://wifo5-03.informatik.uni-mannheim.de/bizer/rdfapi/tutorial/introductionToRAP.htm
8. https://o7services.com/blog/2019/12/21/upload-php-project-on-server-php

Learning Outcomes

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Clinical Genomics**
Type of Course	**DCC**
Course Code	**MG8DCCBIF401**
Course Level	**400-499**
Course Summary & Justification	Clinical Genomics deals with understanding and interpreting genomic components and their relationship with human health conditions. They will learn to analyze sequence data and interpret disease correlations. They are expected to develop an appreciation on the applications of bioinformatics in the diagnosis and management of various disorders.

Semester	VII	Credits 4				Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	**75**
		2	1	1	0	
Pre-requisites	Understanding about genomics					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the Genetics of various diseases	U	1
2	Understand the role of genome analysis in therapeutics	U, Ap	1
3	Analyze the relationships of genetic variations and diseases	An	2
4	Understand and interpret genomic components associated with various diseases	An, A	2
5	Apply the knowledge in genomic tools to predict disease susceptibility	A	2,6
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Diseases, heredity and variation**	15	
	1.1	Role of inheritance in human health conditions		1
	1.2	Cystic fibrosis, Muscular dystrophy, Huntington's disease Diabetes and Familial cancers (its inheritance and role of heredity)		1
	1.3	Mitochondrial disorders		1
	1.4	Genetic variations associated with Schizophrenia		3
	1.5	Autism spectrum disorders and associated genes. Intellectual disabilities and role of various genetic factors		3
	1.6	Major congenital conditions and birth defects		4
	1.7	Reproductive disability and genetics		3
	1.8	Role of environment in modifying hereditary diseases		2
2	**2**	**Clinical Genetics and genomics**	15	
	2.1	Definitions, Role of genetics in diagnosis. Human pedigree analysis and its applications. Risk assessment and genetics. Genetic counseling . Ethical and social issues in clinical genetics		2,4
	2.2	Definitions, Major concepts.-Genomic Medicine		2
	2.3	RNA sequencing and clinical applications		5
	2.4	Variant analysis approaches		5
	2.5	Bioinformatics in Oncogenomics		5
3	**3**	**Tools and databases in clinical genomics**	15	
	3.1	DisGeNET, DISEASES 2.0, OMIM, BCDB, KEGG DISEASE Database, DECIPHER database, Genome Variation Map		5
	3.2	Clinical Genomic Database (CGD), ClinGen, dbVar, ClinVar, HGV database		5
	3.3	UCSC Genome Browser, Genome analysis toolkit (GATK)		5
	3.4	Applications and success stories of clinical genomics; Case study		5
4	**4**	**Practical**	30	
	4.1	UCSC Genome Browser		5

	4.2	Clinical Genomics Case Study		4
	4.3	Variant Analysis in Diseases MiRNA Studies		4
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References:

1. Mount, D. W. (2004). Bioinformatics: Sequence and genome analysis. Cold Spring Harbor Laboratory Press
2. Richard J. Reece, Analysis of Genes and Genomes, John Wiley & Sons, Ltd., Publications, UK, 2004.
3. J.Pevsner, Bioinformatics and Functional Genomics, John-Wiley and Sons, 2009.
4. Clinical Genomics, 1st Edition -2014, Shashikant Kulkarni, Somak Roy
5. Clinical Genomics-A Guide to Clinical Next Generation Sequencing, 2024, Shashikant Kulkarni, Somak Roy
6. Clinical Genomics: Practical Applications For Adult Patient Care (2022) Andrew Howard

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINFORMATICS**
Course Name	**Advanced Bioinformatics**
Type of Course	**DCE**
Course Code	**MG8DCEBIF400**
Course Level	**400-499**
Course Summary	This course helps students in mastering the core concepts of Bioinformatics, including protein structure prediction, NGS, Pharmacogenomics along with its practical, thereby helping them to use their skills in a professional environment.

Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	1	1	0	75
Pre-requisites, if any	Knowledge about basic Bioinformatics					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyze the protein structure using Bioinformatics tool	A	2
2	Understand Metabolism and its pathways	K	1
3	Articulate mitochondrial polymorphisms and about its disease studies	A	1
4	Articulate the basic ideas of pharmacogenomics	An	1
5	Understand various approaches of NGS analysis	A	1
6	Apply different tools used for metabolome analysis	A	2
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**Structure prediction**	12	
	1.1	Protein Secondary structure prediction – Chou-Fasman, Garnier-Osguthorpe, Robson (GOR) methods		1
	1.2	Tertiary Structure prediction- Homology modeling, threading, ab intio method, transmembrane structure prediction		1
	1.3	Neural network concepts, amphipathic helix prediction		1
2	**2**	**Haplogroups and metabolome**	18	
	2.1	haplogroups. Mitochondrial haplogroups, prevalence in mitochondrial haplogroups		3
	2.2	rCRS, SNP, Mitochondrial eve. Human mitochondrial molecular clock. mitochondrial polymorphism, Dysfunction and disease studies.		3
	2.3	Human genographic project		2
	2.4	Introduction to metabolome, metabolomite and metabolomic separation and analysis techniques		2,6
	2.5	metabolic profiling and metabolic fingerprinting,		2,6
	2.6	Metabolome informatics:Resources/ databases of metabolomics, Applications, KEGG and BRENDA		2,6
3	**3**	**Drug metabolism and NGS**	15	
	3.1	Introduction to Pharmacogenomics, Pharmacogenomics vs Pharmacogenetics		4
	3.2	Drug Metabolism, drug interactions, pharmacological actions of drugs. Drug response: Genetic variations, types of polymorphisms		4
	3.3	Personalized medicine; Inter-individual variability, Personalized sequencing, precision therapies		4
	3.4	NGS Method: NGS technologies/platforms, experiment, types and applications. Workflows for various NGS experiments		5

	3.5	Basics of Next Generation Sequence data analysis . Various file formats such as SAM, VCF, BED, ChIP-seq		5
4	**4**	**Practicals**	**30**	
	4.1	Secondary structure prediction tools: GOR, SOPMA		1
	4.2	Tertiary Structure prediction tools		1
	4.3	Homology Modelling		1
	4.4	Metabolic Databases : KEGG		2
5	**5**	**Teacher specific contents**		

References

"Bioinformatics: Sequence and Genome Analysis" by David W. Mount
"Bioinformatics: Algorithms, Data Structures, and Applications" by Bruce R. Donald
"Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids" by Richard Durbin, Sean R. Eddy, Anders Krogh, and Graeme Mitchison
"Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins" edited by Andreas D. Baxevanis and B. F. Francis Ouellette
"Bioinformatics: From Genomes to Drugs" by Thomas Lengauer
"Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology" by Dan Gusfield
"Bioinformatics for Biomedical Science and Clinical Applications" by Yi-Ping Phoebe Chen
"Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools" by Vince Buffalo

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks**

	Lab examination: 25 Viva voce :5 Record: 5

	Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) BIOINFORMATICS**				
Course Name	**ADVANCED R PROGRAMMING**				
Type of Course	**DCE**				
Course Code	**MG8DCEBIF401**				
Course Level	**400-499**				
Course Summary	This Course aims to the usage of R Programming in Bioinformatics. R is an open-source programming language specifically used for statistical computing and graphics. It is one of the widely used programming languages in bioinformatics. It is able to manipulate and analyze large datasets quickly and easily. R also provides a wide range of tools and techniques for analyzing biological data.				
Semester	VIII	Credits		4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial / Practical / Others		
		2	1 / 1 / 0		75
Pre-requisites, if any	Understanding about Basic R programming				

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand an open source statistical programming environment	U	1
2	Analyze the Biological data using R	An	2,3
3	Evaluate Gene Pathways using R	E	2,3
4	Apply machine learning techniques in Biological Data using R	A	2,3
5	Create different graphs for Data visualization	C	2,3

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1**	**R programming : data handling and Bioconductor**	20	
	1.1	R Programming, Introduction, R Studio, Scripts, Console. History Commands		1
	1.2	Variables and Data Types		1
	1.3	Conditional Statements, Loops, Functions and Packages		1
	1.4	Importing and Exporting Data in R, Data Cleaning, Data Manipulation using dplyr Package, Data Visualization using ggplot2		1
	1.5	Basic Bioinformatics Analyses using Bioconductor Packages: Biostring, DNA and protein Analysis using Biostrings		2,3
	1.6	Phylogenetic Data Analysis Using R		2
	1.7	Systems Biology Pathway analysis using iGrpah		3
2	**2.**	**Machine Learning in Bioinformatics using R**	12	
	2.1	SVM Data Analysis using R		4
	2.2	NON SVM Data Analysis using R		4
	2.3	Application for gene expression data analysis using R		4
3	**3**	**Cancer Genomics Data Analysis using R**	13	
	3.1	The Cancer Genome Atlas (TCGA) and cBioportal		5
	3.2	TCGABiolinks and cbioportalR Package in R		5
	3.3	Getting Mutational Data using R From Cancer Databases		5
4	**4**	**Practicals**	30	
	4.1	Program to demonstrate Basic Operations in R		1
	4.2	Program to demonstrate decision making in R		1
	4.3	Program to demonstrate Loops in R		1
	4.4	Programs to demonstrate different data types in R		2
	4.5	Program to visualize Data using ggplot		2
	4.6	Program to analysis Biomolecules Using Biostrings		3

	4.7	Program to demonstrate Pathway analysis		3
	4.8	Data Visualization in SVM and NON SVM Data		4
	4.9	TCGA Data Analysis using R		4
	4.10	Cbioortal Data Analysis and Mutation finding Using R		4
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning, Practical demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Test papers/Assignments/Seminars **Practical: 15 Marks** Lab involvement
	B. Semester End examination **Theory: 50 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (4 out of 6; 4x5=20 marks) Long essay)2 out of 4; 2x10=20 marks) **Practical: 35 Marks** Lab examination: 25 Viva voce :5 Record: 5

References

1. Jared P. Lander, *R for Everyone: Advanced Analytics and Graphics,* 2nd Edition**,** Pearson Education, 2018.
2. S. R. Mani Sekhar and T. V. Suresh Kumar, *Programming with R,*1st Edition*,,* CENGAGE, 2017.
3. Adler, J. (2010). R in a nutshell: A desktop quick reference. "O'Reilly Media, Inc.".
4. Gentleman, R. (2008). R programming for bioinformatics. CRC Press
5. Andrie de Vries , Joris Meys R Programming for Dummies, Wiley
6. Winston Chang R Graphics Cookbook: Practical Recipes for Visualizing Data 2nd Edition "O'Reilly Media, Inc.".
7. Introduction to Bioinformatics with R: A Practical Guide for Biologists (Chapman & Hall/CRC Computational Biology Series)

WEB REFERENCE:

1. https://www.r-project.org/
2. https://www.tutorialspoint.com/r/index.htm
3. **https://cran.r-project.org/**

	Mahatma Gandhi University **Kottayam**					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**AI in Bioinformatics**					
Type of Course	**DCE**					
Course Code	**MG8DCEBIF402**					
Course Level	**400-499**					
Course Summary & Justification	The course provides an in-depth overview of the applications and advancements of artificial intelligence (AI) in the field of bioinformatics. The course explores how AI techniques such as machine learning, deep learning, and data mining can be utilized to analyze and interpret large-scale biological data.					
Semester	VIII	Credits			4	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	60
		3	1	0	0	
Pre-requisites	Basic understanding of soft computing					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand AI and its significance in Bioinformatics	U	1,3
2	Articulate various machine learning algorithms	U	1
3	Apply big data in Bioinformatics	U	2,3
4	Apply various techniques to process big data	A	2
5	Evaluate the use of deep learning techniques on Biological data	E	2
6	Apply deep learning to solve biological problems	A	2,3
7	Apply deep learning in sequence and gene expression analysis and understanding network biology	An	2,3
8	Understand the aspects of ethical issues while using AI	U	7.8

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Artificial intelligence**	12	
	1.1	What is AI and the role of AI in advancing bioinformatics research		1
	1.2	Machine learning fundamentals: supervised and unsupervised learning		1
	1.3	Algorithms in machine learning		2
	1.4	Classification of algorithms: Regression and Clustering algorithms		2
2	**2**	**Data preparation and deep learning**	18	
	2.1	What are high dimensional biological datasets		3
	2.2	Noise reduction in high dimensional data		3
	2.3	Techniques for selecting relevant features from high dimensional datasets including Principal Component Analysis		4
	2.4	Techniques for high dimensionality reduction of high dimensional data		4
	2.5	Introduction to deep learning approaches		5
	2.6	Basic understanding of Convolution Neural Network(CNN) and Recurrent Neural Network(RNN)		6
	2.7	Applications of deep learning in Bioinformatics		6
3	**3**	**Application of AI in Sequence and Gene expression Analysis**	12	
	3.1	AI in DNA sequence alignment		7
	3.2	AI in motif discovery and protein structure prediction		7
	3.3	Techniques for analyzing gene expression data using AI methods		7

	3.4	Differential gene expression analysis		7
	3.5	Gene co-expression network analysis		7
4	**4**	**AI in drug discovery and Network Analysis and its ethical consideration**	**18**	
	4.1	AI in virtual screening, molecular docking and de novo drug design		8
	4.2	Introduction to biological networks: Methods for constructing biological networks		8
	4.3	Basic understanding of network analysis techniques		8
	4.4	Relevance of network analysis in Bioinformatics		8
	4.5	Ethical implications of using AI in Bioinformatics		8
	4.6	Privacy concerns, Responsible data sharing practices, Bias in AI algorithms		8
	4.7	Limitations and challenges of using Artificial Intelligence in biological data analysis		8
5	**5**	**Teacher specific contents**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning, Interactive lectures, exploration & self-learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

References

1. Introduction to Artificial Intelligence by Rajendra Akerkar, PHI
2. Introduction to Artificial Intelligence by Eugene Charniak, Pearson Education
3. Artificial Intelligence by Rich & Knight, Tata McGraw Hills.
4. Introduction to Artificial Intelligence & Expert system by Dan W. Patterson PHI
5. Car J, Sheikh A, Wicks P, Williams MS. Beyond the hype of big data and artificial intelligence: building foundations for knowledge and wisdom. BMC Med. 2019 July 17;17(1):143. doi: 10.1186/s12916-019-1382-x. PMID: 31311603; PMCID: PMC6636050.
6. Pan Zheng, Xiangxiang Zeng, Xun Wang, Shudong Wang (2022). Artificial Intelligence in Bioinformatics and Drug Repurposing: Methods and Applications. Frontiers Media SA.
7. Alexander Heifetz; (2022). Artificial Intelligence in Drug Design. United States: Springer US.
8. Compeau, P., Pevzner, P. (2014). Bioinformatics Algorithms: An Active Learning Approach. United States: Active Learning Publishers.
9. Vadapalli S, Abdelhalim H, Zeeshan S, Ahmed Z. Artificial intelligence and machine learning approaches using gene expression and variant data for personalized medicine. Brief Bioinform. 2022 Sep 20;23(5):bbac191. doi: 10.1093/bib/bbac191. PMID: 35595537; PMCID: PMC10233311.

SUGGESTED READINGS

1. Hamamoto R. Application of Artificial Intelligence for Medical Research. Biomolecules. 2021 Jan 12;11(1):90. doi: 10.3390/biom11010090. PMID: 33445802; PMCID: PMC7828229.

2. Jiang P, Sinha S, Aldape K, Hannenhalli S, Sahinalp C, Ruppin E. Big data in basic and translational cancer research. Nat Rev Cancer. 2022 Nov;22(11):625-639. doi: 10.1038/s41568-022-00502-0. Epub 2022 Sep 5. PMID: 36064595; PMCID: PMC9443637

3. Torkzadehmahani R, Nasirigerdeh R, Blumenthal DB, Kacprowski T, List M, Matschinske J, Spaeth J, Wenke NK, Baumbach J. Privacy-Preserving Artificial Intelligence Techniques in Biomedicine. Methods Inf Med. 2022 Jun;61(S 01):e12-e27. doi: 10.1055/s-0041-1740630. Epub 2022 Jan 21. PMID: 35062032; PMCID: PMC9246509.

4. Artificial Intelligence: A Modern Approach by Stuart Russell, Peter Norvig, and Pearson Education

5. Introduction to Expert System, Peter Jackson, Pearson Education.

6. Artificial Intelligence application programming by M. Tim Jones, Dreamtech Press

	Mahatma Gandhi University **Kottayam**					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Environmental Informatics**					
Type of Course	**DCE**					
Course Code	**MG8DCEBIF403**					
Course Level	**400-499**					
Course Summary & Justification	This course on Environmental Bioinformatics teaches students about the connection between bioinformatics and environmental science, covering fundamental concepts, historical developments, and practical applications of bioinformatics tools.					
Semester	**VIII**	Credits			4	Total Hours:
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	60
		3	1	0	0	
Pre-requisites	Students are expected to have a foundational knowledge in biology and a basic understanding of bioinformatics concepts. applications are recommended to ensure effective engagement with the computational tools introduced in the course.					

COURSE OUTCOMES (CO)

Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the relevance of bioinformatics in environmental science	K	1,7
2	Analyze biological databases relevant to environmental data	A	2,7
3	Articulate the significance of environmental genomics in studying biodiversity	U	1,7
4	Apply functional genomics approaches to study gene function in environmental microorganisms	A	2
5	Use metagenomic analysis, in human microbiome and antimicrobial resistance genes.	A	2
6	Apply eDNA metabarcoding for environmental monitoring	A	2,7

Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Sub-units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Foundations of Environmental Bioinformatics**	12	
	1.1	Overview of Bioinformatics relevance to environmental science, Historical development of environmental bioinformatics		1
	1.2	Key concepts and terminology in environmental bioinformatics.		1
	1.3	Exploration of biological databases relevant to environmental data		2
	1.4	Introduction to computational tools and software used in environmental bioinformatics		2
2	**2**	**Environmental genomics and Metagenomics**	18	
	2.1	Introduction and importance of environmental genomics		3
	2.2	Importance of environmental genomics in studying biodiversity, evolution, and ecosystem dynamics		3
	2.3	Applying comparative genomics to address environmental challenges.		4
	2.4	Functional genomics approaches for studying gene function in environmental microorganisms		4
	2.5	Applications of Environmental Genomics in Conservation and Restoration		5
	2.6	Human Microbiome and Metagenomic Analysis		5
	2.7	Environmental Metagenomics for Ecosystem Analysis		6
	2.8	Antimicrobial Resistance Genes in Metagenomes		6
	2.9	Functional Metagenomics and Bioprospecting		6
	2.10	Bioinformatics Tools for Metagenomic Data Analysis		6
3	**3**	**Environmental Microbiome Analysis**	15	
	3.1	Introduction to Environmental Microbiome Analysis		5
	3.2	Microbial communities in the environment and Applications in soil microbiome concept		4

	3.3	Applications in water microbiome concept		4
	3.4	Applications in air microbiome concept		6
	3.5	Bioinformatics approaches for microbial community analysis		6
4	**4**	**Environmental DNA (eDNA) Metabarcoding**	**15**	
	4.1	Introduction to eDNA Metabarcoding		6
	4.2	Applications in environmental monitoring and Biodiversity Assessment		6
	4.3	eDNA Metabarcoding for Invasive Species Detection		6
	4.4	Bioinformatics tools for processing eDNA metabarcoding data		6
	4.5	Case studies of eDNA applications in biodiversity assessment and ecosystem monitoring		6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning , Interactive lectures, exploration & self learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

References

1. D. Marco (Ed.), Metagenomics: Theory,Methods and Applications,1st Edn., Caister Academic Press, 2010.
2. W. R. Streit and R. Daniel (Eds.),Metagenomics: Methods and Protocols, 1st Edn., Humana Press, 2010
3 N. Hozzein, W. (Ed.). (2020). Metagenomics - Basics, Methods and Applications. IntechOpen. doi: 10.5772/intechopen.78746

4. Francis Martin, Stephane Uroz(2023),Microbial Environmental Genomics (MEG),2nd Edition, MIMB, volume 2605.

SUGGESTED READINGS

1. Paul, P.K. (2022). Environmental Informatics: Basics, Nature, and Applications Using Emerging Technologies with Reference to Issues and Potentialities. In: Paul, P.K., Choudhury, A., Biswas, A., Singh, B.K. (eds) Environmental Informatics. Springer, Singapore. https://doi.org/10.1007/978-981-19-2083-7_1
2. https://www.niehs.nih.gov/about/boards/naehsc/agenda/feb2013/abstract_leping_li_508.pdf
3. https://ts2.space/en/the-use-of-bioinformatics-in-environmental-science-and-ecology/#gsc.tab=0
4. https://www.researchgate.net/publication/354090104_Bioinformatics_and_its_applications_in_environmental_science_and_health_and_its_applications_in_other_disciplines

	Mahatma Gandhi University **Kottayam**					
Programme	**BSc (Hons) BIOINFORMATICS**					
Course Name	**Pharmacogenomics & Drug action**					
Type of Course	**DCE**					
Course Code	**MG8DCEBIF404**					
Course Level	**400-499**					
Course Summary & Justification	The objective of the course is to provide the basics of pharmacogenomics, pharmacodynamics, and toxicogenomics. This also provides the concept of drug interactions and drug metabolism in the host, drug designing using computational tools were introduced.					
Semester	VIII	Credits			4	Total Hours
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	60
		3	1	0	0	
Pre-requisites	Basic idea about pharmacology and its interaction with genetics					

COURSE OUTCOMES (CO)
Upon the completion of the course, the student will be able to:

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Articulate drug metabolism and its biotransformation	U	1
2	Understand the genes affecting the efficacy of the drugs	U	1
3	Build model and validate the target structure	E	2
4	Articulate molecular docking	E	1,2
5	Articulate mode of actions of drugs	E	1
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Unit	Course description	Hrs	CO No.
1	**1**	**Pharmacogenomics and pharmacogenetics**	12	
	1.1	Pharmacodynamics, pharmacokinetics, toxicogenomics and ADME properties		2
	1.2	Process of drug development-clinical trials phase I, II, III and IV. Route of drug administration.		2
	1.3	Nature of cell membrane,Physiological factors related to drug absorption, Drug distribution		1
2	**2**	**Drug Metabolism**	15	
	2.1	Biotransformation (Metabolism) of drugs and related organic compounds - General pathways, sites of drug biotransformation.		1
	2.2	Oxidative reactions, reductive reactions, hydrolytic reactions, conjugation reactions, factors affecting drug metabolism and variability in drug response.		2
	2.3	Microsatellite in studying genetic variation.		2
	2.4	Pharmacodynamics Pharmacogenomics		2
	2.5	Pharmacognosy		2
3	**3**	**Pharmacogenomics in the Disease Treatment**	15	
	3.1	Pharmacogenomics in the treatment of cancer		5
	3.2	Pharmacogenomic inn neurodegenerative diseases, cardiovascular diseases.		5
	3.3	Pharmacogenomics in pharmaceutical industry,		5
	3.4	Ethical issues related to Pharmacogenomics,		5
	3.5	Pharmacogenomics and ethanopharmacology		5
4	**4**	**Drug Designing and action**	18	
	4.1	2-D and 3-D database searching		3
	4.2	Structure-based and Ligand based drug design for all classes of targets.		3
	4.3	QSAR studies, 3D QSAR, CoMFA, ADME prediction		4
	4.4	Introduction to Antibiotics and mechanism of their action. Structure,chemistry and SAR of: Beta lactam Antibiotics, Pencillins		4

	4.5	Antitubercular Agents and their mechanism of action.		5
	4.6	AIDS ,Potential Targets for Anti-HIV agents		5
	4.7	Nucleoside and Non Nucleoside Analogues		5
5	**Teacher specific contents**			

References

Pharmacogenomics: An Introduction and Clinical Perspective" by Joseph S. Bertino Jr.
Principles of Pharmacogenetics and Pharmacogenomics" by Russ B. Altman, David Flockhart, and Shiew-Mei Huang
Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation" edited by Yui-Wing Francis Lam, Peter E. Wu
Goodman & Gilman's: The Pharmacological Basis of Therapeutics" edited by Laurence L. Brunton, Randa Hilal-Dandan, and Björn C. Knollmann
Pharmacogenomics in Drug Discovery and Development" edited by Qing Yan
Genomic and Personalized Medicine" edited by Geoffrey S. Ginsburg and Huntington F. Willard
Pharmacogenomics: Social, Ethical, and Clinical Dimensions" by Mark A. Rothstein

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through e-learning, collaborative learning , Interactive lectures, exploration & self learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Test papers/Assignments/Seminars
	B. Semester End examination **Theory: 70 Marks** Short answers (5 out of 7; 5x2=10 marks) Short essay (6 out of 8; 6x5=30 marks) Long essay)3 out of 5; 3x10=30 marks)

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) BIOINF ORMATICS**
Course Name	**Project**
Type of Course	**PRJ**
Course Code	**MG8PRJ BIF400**
Course Level	**300 – 399**
Course Summary	This course provides students with a foundational understanding of the principles and concepts that form the basis of Bioinformatics

Semester	**8**	Credits			**12**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
			-		12	
Pre- requisites, if Any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To Develop ideas on projects associated with Bioinformatics Techniques	**U**	1,2,10
2	to create an interest in working with different fields related to bioinformatics.	**C**	1,2,10
3	Able to analyze and solve the complex problems raised in the bioinformatics sector	**A**	1,6,10
4	To gain knowledge about research, data interpretation, and data presentation of research work in the future.	**S**	1,2,6,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest(I) and Appreciation (Ap)

Mode of Assessment				
Sl No.	**Points**	**Distribution marks**	**Total Marks**	**Credit**
Internal evaluation				
1.	**Internal** Preparation of Thesis (placement of table, figure and plates)	30	Internal marks - 60	12
2.	Attendance	5		
3.	Presentation of thesis	15		
4.	Certificates & work report	10		
External evaluation				
1.	Final Report submission- Certificates, abstract, introduction, review, material and methods, results and discussion , conclusion and bibliography, tables, figures and plates)	50	External Marks: 140	
2.	Attendance	4		
3.	Punctuality	5		
4.	Relevance of area or topic selected	5		
5.	Conduct	3		
6.	Viva (reponse of questions, concept of objective and knowledge of methodology and justification of results	30		
7.	Presentation –Timing, Display of slide, preparation of results	40		
8.	Completion certificate	3		

BSc Bioinformatics (FYUGP) 5 Day Work Shop

Date : 13th November 2023 to 17th November 20223

Venue : MACFAST College Thiruvalla

Participants

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