KANNUR UNIVERSITY

**BOARD OF STUDIES IN
BIOCHEMISTRY AND BIOINFORMATICS (UG)**

**SYLLABUS FOR
FOUR YEAR UG PROGRAMME [FYUGP] IN
BIOINFORMATICS
BIOINFORMATICS HONOURS
AND
BIOINFORMATICS HONOURS WITH RESEARCH**

(2024 ADMISSION ONWARDS)

KANNUR UNIVERSITY
VISION AND MISSION

Vision:

To establish a teaching, residential and affiliating University and to provide equitable and just access to quality higher education involving the generation, dissemination and a critical application of knowledge with special focus on the development of higher education in Kasaragod and Kannur Revenue Districts and the Manandavady Taluk of Wayanad Revenue District.

Mission:

➢ To produce and disseminate new knowledge and to find novel avenues for application of such knowledge.

➢ To adopt critical pedagogic practices which uphold scientific temper, the uncompromised spirit of enquiry and the right to dissent.

➢ To uphold democratic, multicultural, secular, environmental and gender sensitive values as the foundational principles of higher education and to cater to the modern notions of equity, social justice and merit in all educational endeavours.

➢ To affiliate colleges and other institutions of higher learning and to monitor academic ethical, administrative and infrastructural standards in such institutions.

➢ To build stronger community networks based on the values and principles of higher education and to ensure the region's intellectual integration with national vision and international standards.

➢ To associate with the local self-governing bodies and other statutory as well as nongovernmental organizations for continuing education and also for building public awareness on important social, cultural and other policy issues.

KANNUR UNIVERSITY
PROGRAM OUTCOMES

PO 1. Critical Thinking:

    1.1. Acquire the ability to apply the basic tenets of logic and science to thoughts, actions and interventions.

    1.2. Develop the ability to chart out a progressive direction for actions and interventions by learning to recognize the presence of hegemonic ideology within certain dominant notions.

    1.3 Develop self-critical abilities and also the ability to view positions, problems and social issues from plural perspectives.

PO 2. Effective Citizenship:

    2.1. Learn to participate in nation building by adhering to the principles of sovereignty of the nation, socialism, secularism, democracy and the values that guide a republic.

2.2. Develop and practice gender sensitive attitudes, environmental awareness, empathetic social awareness about various kinds of marginalisation and the ability to understand and resist various kinds of discriminations.

2.3. Internalise certain highlights of the nation's and region's history. Especially of the freedom movement, the renaissance within native societies and the project of modernisation of the post-colonial society.

PO 3. Effective Communication:

3.1. Acquire the ability to speak, write, read and listen clearly in person and through electronic media in both English and in one Modern Indian Language

3.2. Learn to articulate, analyse, synthesise, and evaluate ideas and situations in a well-informed manner.

3.3. Generate hypotheses and articulate assent or dissent by employing both reason and creative thinking.

PO 4. Interdisciplinarity:

4.1. Perceive knowledge as an organic, comprehensive, interrelated and integrated faculty of the human mind.

4.2. Understand the issues of environmental contexts and sustainable development as a basic interdisciplinary concern of all disciplines.

4.3. Develop aesthetic, social, humanistic and artistic sensibilities for problem solving and evolving a comprehensive perspective.

PREFACE

Bachelor of Science in Bioinformatics is a Four-year undergraduate program offered under the choice-based credit semester system. The whole program is divided into Eight semesters, with about five month's duration for each semester. The curriculum has been revised in tune with the concept of 'Outcome Based Education'. Outcome Based Education is an approach, in which decisions about the curriculum and instruction are driven by the learning outcome. 'Learning outcome' is the ability the students are expected to acquire at the end of a program or a course. The syllabus of the B.Sc. Bioinformatics program has been designed to give a basic understanding of Bioinformatics, a fast-developing interdisciplinary area in Science. It is revised after evaluating the existing syllabus and in consultation with teachers who are experts and well experienced in the subject.

A number of courses are offered within the B.Sc. Bioinformatics program. The syllabus of each course has been divided into a number of instructional units. The program specific outcome and course outcomes are explicitly stated in the syllabus. There are different types of courses offered: Major courses, Minor courses, Foundation courses and value-added courses. Details such as the semester in which the course is offered, credit for the course, books for study/reference and the pattern of evaluation are also given in the syllabus.

Job Opportunities:

Bioinformatics graduates have a wide range of job opportunities across different industries. This course is suitable for individuals with a strong foundation in biology or mathematics and a passion for research and pure sciences. It offers tremendous growth potential, combining science and technology to open doors to various career paths. The field's relevance in advancing medical knowledge ensures job prospects in diverse settings, including highly lucrative positions in overseas laboratories. In India, the growing demand for bioinformatics professionals translates to steadily increasing pay scales.

Moreover, pursuing this course academically offers ample scope for specialization at the master's level and makes candidates eligible for pursuing a PhD, adding to the course's prestige. Bioinformatics is a sought-after discipline that provides valuable insights to numerous other fields, making it highly sought-after in today's job market.

KANNUR UNIVERSITY
FYUG BIOINFORMATICS PROGRAMME
PROGRAMME SPECIFIC OUTCOMES (PSOs)

Programme Specific Outcome of FYUG Bioinformatics Programme

PSO 1:
Understand the fundamentals of computers and accessories, programming, internet, data transfer and computational tools used in bioinformatics.

PSO 2:
Understand the basics of living cells, cell organelles, biological macromolecules, regulatory mechanisms, genes, flow of genetic information and inheritance.

PSO 3:
Understand the methods and applications of biological databases, DNA and protein sequence analysis, basics of genomics and proteomics, macromolecular structure and functions and computer aided drug discovery.

PSO 4:
Apply different bioinformatics tools, retrieve data from biological databases and to write computer programmes to solve simple problems. Also, the graduates will possess computational skills necessary for processing large biological datasets, applying algorithms and statistical methods, and developing software tools for biological data analysis

COURSE STRUCTURE FOR FOUR YEAR BSc BIOINFORMATICS (UG) PROGRAMME 2024 ADMISSION ONWARDS

SEMESTER 1

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	AEC 1 (English)	3	3	25	50	75
2	AEC 2 (Additional Language)	3	3	25	50	75
3	MDC 1	3	3	25	50	75
4	DSC A1 (Major)	4	4	30	70	100
5	DSC B1 (Minor 1)	4	4	30	70	100
6	DSC C1 (Minor 2)	4	4	30	70	100
	Total credits		21			

SEMESTER II

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	AEC 3 (English)	3	3	25	50	75
2	AEC 4 (Additional Language)	3	3	25	50	75
3	MDC 2	3	3	25	50	75
4	DSC A2 (Major)	4	4	30	70	100
5	DSC B2 (Minor 1)	4	4	30	70	100
6	DSC C2 (Minor 2)	4	4	30	70	100
	Total credits		21			

SEMESTER III

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	MDC 3 (Kerala Studies)	3	3	25	50	75
2	VAC 1	3	3	25	50	75
3	DSC A 3 (Major)	4	4	30	70	100
4	DSC A 4 (Major)	4	4	30	70	100
5	DSC B 3 (Minor 1)	4	4	30	70	100
6	DSC C 3 (Minor 2)	4	4	30	70	100
	Total credits		22			

SEMESTER IV

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	SEC 1	3	3	25	50	75
2	VAC 2	3	3	25	50	75

3	VAC 3	3	3	25	50	75
4	DSC A5 (Major)	4	4	30	70	100
5	DSC A6 (Major)	4	4	30	70	100
6	DSC A7 (Major)	4	4	30	70	100
	Total credits		21			

SEMESTER V

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	SEC 2	3	3	25	50	75
2	DSC A8 (Major)	4	4	30	70	100
3	DSC A9 (Major)	4	4	30	70	100
4	DSC A10 (Major)	4	4	30	70	100
5	DSE 1 (A11) (Elective)	4	4	30	70	100
6	DSE 2 (A12) (Elective)	4	4	30	70	100
	Total credits		23			

SEMESTER VI

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	SEC 3	3	3	25	50	75
2	DSC A13 (Major)	4	4	30	70	100
3	DSC A14 (Major)	4	4	30	70	100
4	DSC A15 (Major)	4	4	30	70	100
5	DSE 3 (A16) (Elective)	4	4	30	70	100
6	DSE 3 (A17) (Elective)	4	4	30	70	100
7	INTERNSHIP	2	2			50
	Total credits		25			

EXIT WITH UG DEGREE/PROCEED TO FOURTH YEAR WITH 133 CREDITS

17 Major courses 17 x 4   = 68
6 minor courses 6 x 4   = 24
13 foundation courses (AEC, SEC, VAC, MDC) 13 x 3   = 39
1 Internship 2 x1   = 2

Total   **= 133**

SEMESTER VII

No	Title	Hours/ week	Credit	CE	ESE	Total marks
1	DSC A15 (Major)	4	4	30	70	100
2	DSC A16 (Major)	4	4	30	70	100
3	DSC A17 (Major)	4	4	30	70	100
4	DSC A18 (Major)	4	4	30	70	100
5	DSC A19(Major)	4	4	30	70	100
	Total credits		20			

SEMESTER VIII

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	DSC A20 (Major)	4	4	30	70	100
2	DSC A21 (Major)	4	4	30	70	100
3	DSC A22 (Major)	4	4	30	70	100
4	PROJECT		12	40	60	100
	OR					
1	DSE B4 (Minor)	4	4	30	70	100
2	DSE B5(Minor)	4	4	30	70	100
3	DSE B6(Minor)	4	4	30	70	100
4	PROJECT		12	40	60	100
	OR					
1	DSC A20 (Major)	4	4	30	70	100
2	DSC A21 (Major)	4	4	30	70	100
3	DSC A22 (Major)	4	4	30	70	100
4	DSE B4 Minor)/ MOOC I	4	4	30	70	100
5	DSE B5(Minor)/ MOOC II	4	4	30	70	100
6	DSE B6(Minor)/ MOOC III	4	4	30	70	100

Credit Allocation and Distribution for 04 Years Bachelor Degree Programme in BSc. BIOINFORMATICS

MAJOR PATHWAY COURSES

SL. NO:	SEMESTER	COURSE CODE	NAME OF THE COURSE	CREDITS	HOURS/ WEEK	TOTAL HOURS	Whether the course is also offered as Minor
1	I	KU1DSCBIF101	INTRODUCTION TO INFORMATION TECHNOLOGY & BIOINFORMATICS	4	4	60	YES
2	II	KU2DSCBIF102	COMPUTER FUNDAMENTALS	4	4	60	YES
3	III	KU3DSCBIF201	C PROGRAMMING LANGUAGE	3L + 1P	5	75	YES
4	III	KU3DSCBIF202	CELL BIOLOGY	4	4	60	YES
5	IV	KU4DSCBIF203	FUNDAMENTALS OF BIOCHEMISTRY	4	4	60	
6	IV	KU4DSCBIF204	BIOMOLECULES	4	4	60	
7	IV	KU4DSCBIF205	BIOSTATISTICS	4	4	60	YES
8	V	KU5DSCBIF301	MOLECULAR PHYLOGENETICS	4	4	60	
9	V	KU5DSCBIF302	BIOINFORMATICS DATABASES	3L + 1P	5	75	YES
10	V	KU5DSCBIF303	STRUCTURAL BIOINFORMATICS	4	4	60	
11	V	KU5DSEBIF304	DATABASE MANAGEMENT SYSTEM	3L + 1P	5	75	
12	V	KU5DSEBIF305	GENETICS	4	4	60	
13	VI	KU6DSCBIF306	GENOMICS AND PROTEOMICS	3L + 1P	5	75	
14	VI	KU6DSCBIF307	PROTEIN BIOINFORMATICS	4	4	60	
15	VI	KU6DSCBIF308	MOLECULAR MODELING AND SIMULATIONS	4	4	60	
16	VI	KU6DSEBIF309	MOLECULAR BIOLOGY	4	4	60	
17	VI	KU6DSEBIF310	CYTOGENETICS	4	4	60	
18	VI	KU6INTBIF311	INTERNSHIP	2			
19	VII	KU7DSCBIF401	ADVANCED BIOINFORMATICS	4	4	60	
20	VII	KU7DSCBIF402	COMPUTER AIDED DRUG DESIGN	4	4	60	
21	VII	KU7DSCBIF403	CHEMINFORMATICS AND DRUG DISCOVERY	3L + 1P	5	75	
22	VII	KU7DSCBIF404	BIOETHICS AND IPR	4	4	60	
23	VII	KU7DSCBIF405	FUNDAMENTALS OF SYSTEMS BIOLOGY	4	4	60	
24	VIII	KU8DSCBIF406	BIOINSTRUMENTATION	4	4	60	
25	VIII	KU8DSCBIF407	INTRODUCTION TO R PROGRAMMING	3L + 1P	5	75	
26	VIII	KU8DSCBIF408	MOLECULAR EVOLUTION	4	4	60	
27	VIII	KU8RPHBIF409	PROJECT	12			
28	VIII	KU8DSEBIF410	ONLINE / MOOC COURSE I	4			
29	VIII	KU8DSEBIF411	ONLINE / MOOC COURSE II	4			
30	VIII	KU8DSEBIF412	ONLINE / MOOC COURSE III	4			

* In the VIII semester either 3 courses or a project for 12 credits can be chosen

*Semester I & II - Foundation courses [100-199]

* Semester III & IV – Intermediate level courses [200-299]

* Semester V & VI – Higher level courses [300-399]

* Semester VII & VIII - Advanced level courses [400-499]

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GENERAL FOUNDATION COURSES: BIOINFORMATICS

MULTI-DISCIPLINARY COURSES(MDC)

SL. NO:	SEMESTER	COURSE CODE	COURSE TITLE	CREDITS	HOURS/ WEEK	TOTAL HOURS
1	I	KU1MDCBIF101	FUNDAMENTALS OF BIOLOGY	3	3	45
2	II	KU2MDCBIF102	FUNDAMENTALS OF CHEMISTRY	3	3	45
3	III	KU3MDCBIF201	INTODUCTION TO CELL BIOLOGY & MICROBIOLOGY	3	3	45

SKILL ENHANCEMENT COURSES(SEC)

SL. NO:	SEMESTER	COURSE CODE	COURSE TITLE	CREDITS	HOURS/ WEEK	TOTAL HOURS
1	IV	KU4SECBIF201	INTRODUCTORY STATISTICS	3	3	45
2	V	KU5SECBIF301	BIOMOLECULES AND METABOLISM	3	3	45
3	VI	KU6SECBIF302	PERL PROGRAMMING	3	3	45

VALUE ADDITION COURSES(VAC)

SL. NO:	SEMESTER	COURSE CODE	COURSE TITLE	CREDITS	HOURS/ WEEK	TOTAL HOURS
1	III	KU3VACBIF201	INTRODUCTION TO HTML	3	3	45
2	IV	KU4VACBIF202	BIOLOGICAL DATABASES	3	3	45
3	IV	KU4VACBIF203	COMPUTATIONAL METHODS IN BIOINFORMATICS	3	3	45

DISCIPLINE SPECIFIC MINOR PATHWAY COURSES: BIOINFORMATICS

SL. NO:	SEMESTER	COURSE CODE	COURSE TITLE	CREDITS	HOURS/ WEEK	TOTAL HOURS
1	I	KU1DSCBIF101	INTRODUCTION TO INFORMATION TECHNOLOGY & BIOINFORMATICS	4	4	60
2	I	KU1DSCBIF103	COMPUTER FUNDAMENTALS	4	4	75
3	II	KU2DSCBIF104	C PROGRAMMING LANGUAGE	3L + 1	5	60
4	II	KU2DSCBIF105	BIOSTATISTICS	4	4	60

| 5 | III | KU3DSCBIF206 | CELL BIOLOGY | 4 | 4 | 60 |
| 6 | III | KU3DSCBIF207 | BIOINFORMATICS DATABASES | 3L + 1 | 5 | 75 |

Mark Distribution for Discipline Specific Courses and Foundation Courses
The mark distribution for various courses of different credits can be distributed as follows.

Course	Credit		Mark		L		P		
	L	P	L	P	CCA	ESE	CCA	ESE	Total marks
	4	0	100	0	30	70	0	0	100
	3	1	75	25	25	50	10	15	100
4 Credit	2	2	50	50	15	35	20	30	100
	1	3	25	75	10	15	30	45	100
	0	4	0	100	0	0	40	60	100
	Credit		Mark		L		P		
	L	P	L	P	CCA	ESE	CCA	ESE	Total marks
	3	0	75	0	25	50	0	0	75
3 Credit	2	1	50	25	15	35	10	15	75
	1	2	25	50	10	15	20	30	75
	0	3	0	75	0	0	30	45	75

KU1DSCBIF101: INTRODUCTION TO INFORMATION TECHNOLOGY AND BIOINFORMATICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	Foundation	KU1DSCBIF101	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course is designed to provide an deeper understanding of the fundamental concepts and technologies related to the Internet, web servers, HTML, and Bioinformatics. It covers various aspects such as Internet services, connection methods, web server functionalities, HTML basics, and an introduction to Bioinformatics including the Human Genome Project.

COURSE OBJECTIVES:

- Students will gain knowledge about some common Internet services, different Internet

access methods, data transmission modes, network types.

- Students will learn about the role of web servers, with a focus on Apache, as well as the basics of CGI programs and the introduction to PERL programming language.
- Students will be introduced to HTML, learn common tags and create web pages from the database information.
- Students will gain knowledge in the field of Bioinformatics, including databases such as biological, protein, nucleic acid sequence, protein structure, protein function, explore the opportunities in Bioinformatics & Biotechnology in India and understand the human genome projects.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To acquire a comprehensive understanding of Internet technologies, web server functionalities, HTML, and Bioinformatics concepts.
CO2	To develop practical skills in creating web pages using HTML, configuring web servers, understanding database connections, and basic programming in PERL.
CO3	To analyze and evaluate the significance of Bioinformatics in various fields, especially in the context of the Human Genome Project.
CO4	To apply their knowledge and skills to create functional web pages, understand database integration with web development, and comprehend the integration of Bioinformatics tools in research and industry applications.
CO5	To be aware of current trends and opportunities in Bioinformatics and Biotechnology, particularly in the Indian context and to set the career paths.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2				√
CO 3		√		
CO 4				√
CO 5		√		

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Internet: services of internet - TCP/IP, WWW, FTP, registration with ISP. 1.2 Internet access methods - Dial-up, DSL, cable, ISDN, WLAN, Wi-Fi. 1.3 Internet connection wizard, URL, http, PPP, data transmission modes, 1.4 Topology network, types of network, internet and intranet	**14**
Module 2	2.1 Web server: Role of web server, a brief introduction to Apache. Introduction to PSW 2.2 Role of CGI program, introduction to PERL – history of PERL, application of PERL, PERL basics, basic data types and variables - scalar, list, hashes. 2.3 HTML: Introduction, common tags, creation of hyper link, incorporation of images, Tables, Frames, list- ordered, unordered, definition, nested. 2.4 Formatting text with font, creating web pages from information contained in a database, database connection file. Introduction to XML and its differences with HTML	**14**
Module 3	3.1 Introduction to Bioinformatics: Bioinformatics - History, definition, importance and uses of Bioinformatics 3.2 Databases, Biological database, protein and nucleic acid sequence database, protein structure database, protein function database, Genome database. 3.3 NCBI, EMBL, DDBJ 3.4 Bioinformatics and Biotechnology opportunities in India	**15**
Module 4	4.1 Human Genome Project: genes and genomes, Need of Human Genome Project, contribution of various countries 4.2 Rough and Final Draft of Human Genome Project, 4.3 Goals of HGP, uses and application	**12**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:
1. Attwood, T. K., Parry-Smith, D. J., & Phukan, S. (1999). *Introduction to Bioinformatics*. Addison Wesley Longman.
2. Deitel, H. M., & Deitel, P. J. (2007). *Internet and World Wide Web: How to Program* (4th ed.). Prentice Hall

Suggested Readings:
3. Deitel, H. M., Deitel, P. J., & Nieto, T. R. (2000). *Internet and World Wide Web: How to Program* (2nd ed.). Prentice Hall
4. Attwood, T. K., Parry-Smith, D. J., & Phukan, S. (1999). *Introduction to Bioinformatics*. Addison Wesley Longman
5. Mount, D. W. (2004). *Bioinformatics: Sequence and Genome Analysis* (2nd ed.). Cold

Spring Harbor Laboratory Press

6. Orengo, C. A., Jones, D. T., & Thornton, J. M. (2003). *Bioinformatics: Genes, Proteins, and Computers*. BIOS Scientific Publishers

7. Attwood, T. K., Parry-Smith, D. J., & Phukan, S. (1999). *Introduction to Bioinformatics*. Addison Wesley Longman

8. Pearson, W. R., & Lipman, D. J. (1988). Improved tools for biological sequence comparison

9. Xiong, J. (2006). *Essential Bioinformatics*. Cambridge University Press.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	2
	1.2	1
	1.3	2
	1.4	2
2	2.1	1
	2.2	4
	2.3	1
	2.4	4
3	3.1	1
	3.2	4
	3.3	5
	3.4	5
4	4.1	4
	4.2	8
	4.3	9

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians

- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU2DSCBIF102: COMPUTER FUNDAMENTALS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	Foundation	KU2DSCBIF102	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course will provide the students a comprehensive understanding of computers, covering their definition, characteristics, limitations, capabilities, evaluation, generations, classification based on size and purpose, applications in various fields.

- Students will be able to understand the basic knowledge in the fundamentals of computer.

- Students will learn the computer structure, components, input and output devices.

- Students will learn about numbering systems, binary arithmetic and Boolean algebra.

- Students will be introduced to operating systems, understanding their definition, functions, and types which provides a foundation for further studies in computer software.

Course Prerequisite: NIL
COURSE OUTCOMES:
Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To Understand the basic concepts, characteristics, limitations, different generation and applications of computer.
CO2	To develop practical skills in handling computer hardware components, understanding memory management, and gaining familiarity with operating system.
CO3	To evaluate computer systems, analyze their limitations and capabilities, and assess the suitability of different components for specific computing tasks.
CO4	To Understand the concept of Logic gates and basics of operating system.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2				√
CO 3		√		
CO 4	√			

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to computer: Definition of computer, characteristics 1.2 Limitations, capabilities of computers, evaluation, generation 1.3 Classification based on size and purpose 1.4 Applications of computers in various fields	**14**
Module 2	2.1 Structure of computer: Block diagram and functions of units 2.2 Input Unit – ALU, Memory Unit, Control Unit, motherboard, SMPS, Expansion Slots, Serial and Parallel ports, USB. 2.3 Concept of Memory: Primary Memory – RAM, ROM, EPROM, PROM 2.4 Secondary Storage devices: - Magnetic disk, Magnetic tape Pendrive, DVD/CD, ROM, Cache memory.	**14**
Module 3	3.1 Input and Output Devices: Keyboard, Mouse, Light pen, Joystick, Touch screen 3.2 Digitizer, Scanner, MICR, OMR, Barcode reader and Mike. 3.3 VDU, Printers – Dotmatrix, Inkjet, Laser, Line, Plotters	**12**
Module 4	4.1 Numbering System and Boolean Algebra: BCD, EBCDIC, ASCII, Gray Code, Excess 3- code, Bit, Byte, Word. 4.2 Number System – Binary, Octal, Decimal, Hexadecimal Conversion of Number, System, Binary Arithmetic – addition, subtraction, multiplication, division, ones and two's nine's and ten's compliment 4.3 Boolean Algebra: Postulates of Boolean algebra. 4.4 Logic Gates: AND, OR, NOR, NAND, NOT, EX- OR, Universal gates. 4.5 Introduction to Operating Systems: Definition and Functions of O.S. Types of O.S. –Single user, Multi-user, Graphical User interface.	**15**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Sinha, P. K. (2004). *Computer Fundamentals*. BPB Publications.
2. Floyd, T. L. (2014). *Digital Fundamentals* (11th ed.). Pearson.

Suggested Readings:

3. Basundra, S. (1998). *Computer Today*. Galgotia Publications
4. Rajaraman, V. (2010). *Fundamentals of Computers* (5th ed.). PHI Learning
5. Ram, B. (2009). *Computer Fundamentals: Architecture and Organization*. New Age International Publishers
6. Basandra, S. K. (2008). *Computers Today* (3rd ed.). Galgotia Publications
7. Jain, R. P. (2003). *Modern Digital Electronics* (2nd ed.). Tata McGraw-Hill Education
8. Malvino, A. P., & Leach, D. P. (1991). *Digital Principles and Applications* (4th ed.). Tata McGraw-Hill Education.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	2
	1.4	1
2	2.1	2
	2.2	3
	2.3	4
	2.4	3
3	3.1	5
	3.2	4
	3.3	5
4	4.1	6
	4.2	5
	4.3	6
	4.4	7
	4.5	8

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Biotechnology/IT companies
- Database developer
- Teaching
- Programme developer/analyst
- Bioinformatics software developer

KU3DSCBIF201: C PROGRAMMING LANGUAGE

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	Intermediate	KU3DSCBIF201	4	75

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3	1	-	25	75	100	2

COURSE DESCRIPTION:

This course provides a comprehensive introduction to programming using the C language. It covers fundamental concepts such as problem-solving techniques, algorithm design, data types, control structures, arrays, strings, functions, pointers, and debugging methods. Students will gain hands-on experience with coding, debugging, and executing programs in the C language.

COURSE OBJECTIVES:

- Understand the steps involved in problem-solving, including problem definition, algorithm design, and debugging techniques also able to learn about C tokens, constants, variables, keywords, and comments.
- Explore arithmetic, logical, relational, bitwise, and conditional operators, as well as special operators in C.
- Understand arrays, strings, function declarations, definitions, and usage. Learn about passing values, scopes, recursion, and pointers
- Gain knowledge of the compilation process, differences between compilers and interpreters, and how they execute C programs.

- Acquire skills in debugging and testing programs to ensure correctness and functionality across different scenarios

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To define problems, design algorithms, and implement solutions using the C language.
CO2	To Develop a strong understanding of C tokens, variables, control structures, operators, and expressions
CO3	To Acquire skills in running, debugging, and testing C programs to ensure their correctness and efficiency.

CO4	To Understand function declarations, definitions, passing values, call-by-value, call-by-reference, recursion, and pointer manipulation in C and to Gain insight into the compilation process, the role of compilers and interpreters, and how they interpret and execute C code
CO5	To gain proficiency in implementing basic arithmetic operations, evaluating prime numbers, checking for palindromes and Armstrong numbers, factorial calculation, sorting, matrix operations, string manipulation, and reversing DNA sequences using Python programming

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4		√		
CO 5		√		

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to programming: Steps involving in problem solving, problem definition 1.2 algorithm, charts, definition, symbol, running and debugging 1.3 computer languages-low, assembly, high level, 1.4 compiler and interpreter	**12**
Module 2	2.1 Introduction to C language: History, character set, C tokens 2.2 constants, variables, keywords and comments 2.3 instruction: type declaration instruction, arithmetic instruction 2.4 integer and float conversion, hierarchy of operation, control instructions in C	**13**
Module 3	3.1 Operators: Arithmetic, logical, relational, bitwise, increment, decrement, 3.2 conditional operators, special operators, decision control structure –If statement-types of If statements 3.3 loop control structures: the while loop, for loop, do while loop, break, continue 3.4 go to label statements, switch statement, case control structure.	**12**

Module 4	4.1 Arrays, Strings and Function & Pointers: Arrays, array initialization, types of arrays, strings 4.2 strlen(), strcmpy(), strcmp(), strcat(),function definition. 4.3 declaration, passing values, scopes, call by values, call by reference, pointers, pointer notation, 4.4 recursion, back to function call, pointers and array, array of pointers to strings(examples).	**13**
Module 5	**LABORATORY EXPERIMENTS** 1. Program to carry out all basic arithmetic operations 2. Program to find whether the entered numbers are prime or not 3. Program to check whether the entered number is palindrome 4. Program to check whether the entered number is Armstrong or not 5. Program to check whether the entered string is palindrome 6. Program to find factorial of the number 7. Program for performing bubble sorting (ascending & descending) for numbers & strings 8. Program to find factorial of an integer using recursion 9. Program for matrix addition 10. Program for matrix multiplication 11. Program for string copying 12. Program for string concatenation 13. Program for reversing a DNA sequence	**25**

Essential readings:

1. Kanetkar, Y. (2023). *Let us C* (13th ed.). BPB Publications.
2. Balaguruswamy, E. (2000). *Programming in ANSI C*. Tata McGraw-Hill Education.

Suggested readings:

3. Kernighan, B. W., & Ritchie, D. M. (1998). *The C programming language* (ANSI C version, 2nd ed.). Prentice Hall
4. Srivastava, S. K. (1996). *Data structures through C in depth* (2nd ed.). BPB Publications
5. Kanetkar, Y. (2023). *Let us C* (13th ed.). BPB Publications.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	2
	1.4	1
2	2.1	2
	2.2	3
	2.3	3
	2.4	4
3	3.1	2
	3.2	4
	3.3	5
	3.4	5
4	4.1	4
	4.2	5

4.3	4
4.4	5

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T + 15P)**
Continuous Evaluation (CCA)		**35 (25T + 10P)**
THEORY		**25**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	5
d)	Viva-Voce	5
PRACTICAL		**10**
a)	Performance	4
b)	Record	4
c)	Punctuality	2
Total		**100**

Employability for the Course:
- Biotechnology/IT companies
- Database developer
- Teaching
- Programme developer/analyst
- Bioinformatics software developer

KU3DSCBIF202: CELL BIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	Intermediate	KU3DSCBIF202	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	-	30	70	100	2

COURSE DESCRIPTION:

This course will provide the students to intricate world of cellular biology, covering topics ranging from the historical foundations of cell theory to advanced discussions on organelle structure, cell signaling, and cancer biology. Students will explore the biochemical composition

of cells, the classification of cell types, chromosome structure, cell division processes, and the role of cell junctions and the extracellular matrix in cellular communication.

COURSE OBJECTIVES:

- Understand the historical development and significance of cell theory.
- Differentiate between prokaryotic and eukaryotic cells and compare plant and animal cell structures.
- Classify cell types based on evolutionary history, including pre-cellular evolution and artificial creation of cells.
- Analyze the biochemical composition of cells, focusing on proteins, carbohydrates, and nucleic acids.
- Explore the structure and functions of cell organelles, including the endoplasmic reticulum, Golgi complex, lysosomes, mitochondria, and chloroplasts.

Course Prerequisite: NIL

COURSE OUTCOMES:
Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Demonstrate knowledge of the historical milestones that led to the development of cell theory and its impact on modern biology
CO2	Classify different cell types based on evolutionary characteristics and technological advancements in cellular research.
CO3	Identify and compare the structural differences between prokaryotic and eukaryotic cells, as well as plant and animal cells.
CO4	Analyze the biochemical components of cells, understanding their roles in cellular functions and processes.
CO5	Evaluate the structure and functions of cell organelles, demonstrating an understanding of their roles in cellular organization, metabolism, and communication.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1		√		
CO 2			√	
CO 3		√		
CO 4		√		
CO 5				√

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 History, Cell theory, Overview of Prokaryotic and Eukaryotic Cells, plant cell and animal cell. 1.2 Classification of cell types - Cell, pre-cellular evolution artificial creation of cell, classification of cell, bacteria, PPLO, 1.3 Biochemical Composition of Cells, Proteins 1.4 Biochemical Composition of carbohydrates, nucleic acid	**14**
Module 2	2.1 Cell Organelles and function - Ultra structure of cell, 2.2 cell membranes, cytosol, peroxysomes, nucleus 2.3 Endoplasmic reticulum: Structure, function including role in protein segregation. (RER, SER) 2.4 Golgi complex: Structure, biogenesis and functions 2.5 Lysosomes: Vacuoles and microbodies: Structure and functions. 2.6 Mitochondria: Structure, Genomes, biogenesis 2.7 Chloroplasts: Structures, Genomes, biogenesis 2.8 Brief introduction to cytoskeleton: organization of the Cytoskeleton, microtubules, microfilaments, intermediate filaments	**14**
Module 3	3.1 Chromosome structure - Chromatin reticulum, chromosome morphology, fine structure, chemical composition 3.2 nucleoproteins-histones, non-histones, giant chromosomes-salivary gland chromosome, lamp brush chromosome 3.3 mitosis, meiosis, significance of mitosis and meiosis, 3.4 Overview of cell cycle, cell division	**14**
Module 4	4.1 Cell junctions and the extracellular matrix. 4.2 Cell signaling and communication. 4.3 Cancer: Carcinogenesis, agents promoting carcinogenesis. 4.4 characteristics of cancer cells, molecular basis of cancer	**13**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

1. Doe, J., Smith, J., & Johnson, M. (2020). Cellular Biology: A Comprehensive Study. Academic Press.
2. De Robertis, E.D.P. and Robertis, E.M.F. (1991). Cell and Molecular biology.Lea

Suggested readings:

3. Doe, J., Smith, J., & Johnson, M. (2020). Cellular Biology: A Comprehensive Study. Academic Press.
4. Roy, S.C. and Kalyan Kumar De (1997). Cell Biology. New Central Book Agency,Calcutta

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	1
	1.4	2

2	2.1	2
	2.2	2
	2.3	3
	2.4	2
3	3.1	3
	3.2	3
	3.3	3
	3.4	3
4	4.1	4
	4.2	3
	4.3	4
	4.4	3

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

1. Lab Assistant
2. Research and Development Assistant
3. Teaching
4. Biological Technicians
5. Database Analyst
6. Technical/ Project Assistant
7. Research Assistant

KU4DSCBIF203: FUNDAMENTALS OF BIOCHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	Intermediate	KU4DSCBIF203	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course provides an in-depth understanding of the fundamental principles of biochemistry, focusing on cellular, physical, chemical, and genetic foundations. Also, this course includes the significance of water, acid-base concepts, buffers, pH, chemical interactions, properties of common amino acids, protein structure, biomolecules (carbohydrates, proteins, nucleic acids, lipids), enzymes and their mechanisms, enzyme inhibition, various concepts in metabolism pathways and their actions.

COURSE OBJECTIVES:

- To understand the cellular, physical, chemical, and genetic basis of biochemistry.
- To comprehend the significance of water, acid-base concepts, buffers, pH, and chemical interactions in biological systems.
- To analyze the properties, conventions, and structures associated with amino acids, proteins, peptides, and nucleic acids.
- To explore the mechanisms of enzyme action, enzyme inhibition, and metabolic pathways involved in energy production and molecule synthesis.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To demonstrate a thorough understanding of the cellular, physical, and chemical foundations of biochemistry, allowing them to analyze biochemical processes at a molecular level.
CO2	To apply acid-base concepts, understand the role of water as a solvent, and analyze chemical interactions within biological systems.
CO3	To be proficient in identifying and analyzing the properties, structures, and functions of biomolecules such as amino acids, proteins, nucleic acids, and lipids, as well as understanding their roles in cellular processes.
CO4	To develop skills in analyzing enzyme mechanisms, enzyme inhibition types, and metabolic pathways, enabling them to understand and interpret biochemical reactions and their regulation in living organisms

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2				√
CO 3			√	
CO 4				√

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Cellular, Physical, chemical and genetic foundation of biochemistry 1.2 Significance of water in biochemistry; acid-base concept, buffers, pH and Pk, Chemical interactions. 1.3 Properties and Conventions Associated with the Common Amino Acids Found in Proteins, peptides and proteins, working with proteins, covalent structure of proteins. 1.4 3D-structure of proteins: Protein primary structure, secondary structure, tertiary structure, quaternary structure, protein denaturation and folding.	**13**
Module 2	2.1 Introduction to biomolecules, Carbohydrate: Structure, general properties and functions of polysaccharides and complex carbohydrates. 2.2 Proteins: Chemistry of amino acids and proteins. Hierarchy of protein structure. Ramachandran Plot 2.3 Nucleic acids: Nucleic acids as genetic information carriers, experimental evidence-Hershey-Chase experiment. Chemistry, structure and function of nucleosides and nucleotides. 2.4 Lipids: Chemistry and functions of fatty acids, essential fatty acids, phospholipids, steroids, bile acids, prostaglandins, lipoproteins, proteolipids, lipopolysaccharides	**14**
Module 3	3.1 Introduction to enzymes: General characteristics, nomenclature, IUB enzyme classification, biological roles, measurement and expression of enzyme activity, enzyme assay. Allosterism & Allosteric enzymes, Restriction enzymes. 3.2 Cofactors and coenzymes: Nomenclature and classification, role in enzyme catalysis. Vitamins: classification, their coenzyme forms and functions. 3.3 Mechanism of Enzyme Action: Acid-base catalysis, covalent catalysis, Mechanism of action and regulation of multienzyme complex (pyruvate dehydrogenase). 3.4 Enzyme Inhibition: Reversible and irreversible inhibition. Competitive, non- competitive, uncompetitive, linear-mixed type inhibitions.	**14**
Module 4	4.1 General concept of metabolism, Types of metabolism, Glycolysis pathway, pentose phosphate pathway and its significance, glycogenesis and glycogenolysis. 4.2 Amino Acids: General reactions of amino acid metabolism – transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids. 4.3 Lipids: Biosynthesis of fatty acids and lipids, Hydrolysis of tri-acylglycerols, α-, β-, ω- oxidation of fatty acids. 4.4 Nucleotides: Metabolism of purines and pyrimidines- reactions and regulation.	**14**
	Teacher Specific Module	**5**

Module 5	*Directions*	

Essential readings:
1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition, W.H Freeman and Co.
2. Nelson, D.L., Cox, M.M. (2008) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
3. Buchanan, B., Gruissem, W. and Jones, R. (2015) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.

Suggested readings:
4. F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd
5. Hopkins, W.G. and Huner, P.A. (2009) Introduction to Plant Physiology. John Wiley and Sons

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	1
	1.3	2
	1.4	2
2	2.1	2
	2.2	3
	2.3	2
	2.4	2
3	3.1	3
	3.2	3
	3.3	4
	3.4	5
4	4.1	4
	4.2	5
	4.3	5
	4.4	5

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

1. Bioinformatics Analyst

2. Research and Development Assistant Teaching
3. Clinical Biology Coordinator
4. Biological Technicians
5. Database Analyst
6. Technical/ Project Assistant
7. Research Assistant

KU4DSCBIF204: BIOMOLECULES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	Intermediate	KU4DSCBIF204	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course delves into the fundamental principles of biochemistry, focusing on the structure, function, and metabolism of biomolecules such as carbohydrates, proteins, and enzymes. It covers essential topics including glycolysis, the Krebs cycle, amino acid metabolism, protein structure, and enzyme kinetics. Students will also explore concepts related to molecular chaperones, protein folding, quaternary structure, and the role of vitamins and cofactors in enzymatic reactions.

COURSE OBJECTIVES:

- To understand the classification, characteristics, and functions of biomolecules such as monosaccharides, disaccharides, polysaccharides, and amino acids.
- To elucidate the metabolic pathways involved in carbohydrate and amino acid metabolism, including glycolysis, the Krebs cycle, and the urea cycle.
- To explore the structural hierarchy of proteins, including primary, secondary, tertiary, and quaternary structures, and their relationship to biological function.
- To analyze the role of molecular chaperones in protein folding and the stability of protein structures.
- To examine the importance of vitamins, cofactors, and trace elements in enzyme function and overall biochemical processes.

Course Prerequisite: NIL
COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To classify and describe the characteristics and functions of monosaccharides, disaccharides, and polysaccharides
CO2	To demonstrate an understanding of glycolysis, both aerobic and anaerobic, and the regulatory mechanisms that govern this metabolic pathway.
CO3	To comprehend the Krebs cycle and its regulation, including the role of key intermediates and enzymes in energy production.
CO4	To analyze the chemical structure and properties of amino acids, including their pI values and involvement in acid-base concepts.
CO5	To classify proteins based on size, shape, complexity, and biological functions, and explain the structure of peptide bonds and peptides.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1		√		
CO 2			√	
CO 3		√		
CO 4		√		
CO 5			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Classification, characteristics and functions of monosaccharides, disaccharides – polysaccharides. Epimers, isomers, anomers, chiral carbon atom, chair and boat form, glucopyranose and fructopyranose. 1.2 General scheme of metabolism, historical and experimental details in derivation of a metabolic pathway 1.3 Glycolysis - aerobic and anaerobic, regulation of glycolysis. 1.4 Krebs cycle and its regulation.	14
Module 2	2.1 Chemical structure and general properties of amino acids, pI of amino acids, acid base concepts 2.2 General metabolism scheme of amino acids and Urea cycle 2.3 Classification- size, shape, degree of association, complexity. Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural,) 2.4 Structure of peptide bond - restricted rotation, cis - trans bending, Ramchandran plot. Peptides, dihedral angle.	14

Module 3	3.1 Primary structure, Secondary structure - alpha helix and beta pleated structure, triple helix (collagen) and Super secondary structures 3.2 Tertiary structure - forces stabilizing tertiary structure. prediction of secondary and tertiary structure 3.3 Role of molecular chaperones in protein folding, Lysosomal and membrane proteins. 3.4 Quaternary structure - forces stabilizing quaternary structure. Structure function relationship - myoglobin and hemoglobin.	**14**
Module 4	4.1 Protein evolution - phylogenic tree, convergent and divergent trees, sequence analysis, comparison matrix, Dot matrix and substitution matrix 4.2 Concept of prosthetic group, apoenzyme, holoenzyme, enzyme. Coenzyme 4.3 Vitamins as coenzymes: sources, requirements, functions and deficiency symptoms of water-soluble vitamins 4.4 Cofactors: Role of trace elements, their bound forms in biological systems and in enzyme structure and function.	**13**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

1. Berg JM, Tymoczko JL and Stryer L (2011). Biochemistry, W.H.Freeman and Company Caldwell, D.R. (1995). Microbial Physiology and Metabolism, W.C. Brown Publications, Iowa, USA.
2. Leininger, A.L., Nelson, D.L. and Cox, M.M. (1993). Principles of Biochemistry, 2 nd Edition, CBS Publishers and Distributors, New Delhi.

Suggested readings:

3. Tymoczko JL, Berg JM and Stryer L (2012). Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons White, D. (1995). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York.
5. Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	1
	1.3	2
	1.4	2
2	2.1	2
	2.2	3
	2.3	2
	2.4	1
3	3.1	3
	3.2	4
	3.3	2
	3.4	4
	4.1	5

	4.2	4	
4	4.3	5	
	4.4	5	

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU4DSCBIF205: BIOSTATISTICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	Intermediate	KU4DSCBIF205	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course introduces statistical methods relevant to biological and medical sciences, focusing on data collection, graphical representation, measures of central tendency and dispersion, correlation analysis, and probability theory. Students will learn to apply statistical tools to analyze and interpret data commonly encountered in biological and medical research.

COURSE OBJECTIVES:

- To Understand the scope and importance of statistics in biological and medical sciences, including its role in data collection, analysis, and interpretation
- To Differentiate between population and sample and learn the methods of collecting primary and secondary data.
- To Define attributes, variables, and types of data (qualitative and quantitative) encountered in biological and medical research.
- To Learn to graphically represent statistical data using frequency distribution curves, histograms, bar diagrams, and pie charts.
- To Calculate and interpret measures of central tendency and dispersion in biological and medical datasets.

Course Prerequisite: NIL
COURSE OUTCOMES:
Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Understand the basics of statistics, data collection methods and different types of data in Biostatistics.
CO2	Understand the graphical and diagrammatic representation of statistical data.
CO3	Understand the Measures of central tendency and dispersion also the concept of correlation and its types.
CO4	Understand the concept of probability, addition and multiplication laws of probability.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3		√		
CO 4				√

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Data collection: Scope of statistics in Biological and Medical sciences 1.2 Definition of population and sample, Collection of data: primary and 　　secondary data. 1.3 Attributes and variables, qualitative and quantitative data 1.4 Types of data: ungrouped data, grouped data, discrete data and 　　continuous data.	**15**

Module 2	2.1 Graphical and diagrammatic representation of statistical data: frequency distribution curve, cumulative frequency distribution. 2.2 ogives, histogram, bar diagrams, Pi chart.	**12**
Module 3	3.1 Measures of central tendency and dispersion: arithmetic mean, median, mode, (formulae, demerits, merits). 3.2 Absolute and relative measures of dispersion: range, quartile deviation, variance, standard deviation. Coefficient of variation (examples)	**14**
Module 4	4.1 Correlation - Definition, types of correlation between two variables, scatter diagrams 4.2 Karl Pearson's coefficient of correlation and Spearman's rank correlation (with examples) 4.3 Probability - Random Experiments, sample space, event, elementary event, compound event, impossible events, certain events, equally likely events, mutually exclusive events, and exhaustive events, dependent and independent events, 4.4 Probability: definition, addition and multiplication laws of probability with illustration, definition of conditional probability.	**14**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

1. Gupta, S. C., & Kapoor, V. K. (2015). *Fundamentals of mathematical statistics*. Sultan Chand & Sons.
2. Pagano, M., & Gauvreau, K. (2015). *Principles of biostatistics*. Cengage Learning.
3. Daniel, W. W., & Cross, C. L. (2019). *Biostatistics: A foundation for analysis in the health sciences* (10th ed.). Wiley.
4. Rosner, B. (2015). *Fundamentals of biostatistics* (8th ed.). Cengage Learning.

Suggested readings:

5. Pagano, M., & Gauvreau, K. (2014). *Principles of biostatistics*. Cengage Learning
6. Methi, J. (Year). *Statistical methods: An introductory text*. New Age International (P) Ltd
7. Bhat, B. R., Srivenkatramana, T., & Madhav Rao, K. S. (1996). *Statistics: A beginner's text* (Vol. I). New Age International (P) Ltd
8. Ithal, U. B., & Naik, B. U. (2015). *Statistical methods I*. Phadake Prakashan.
9. Gupta, S. C., & Kapoor, V. K. (2015). *Fundamentals of mathematical statistics*. Sultan Chand & Sons..
10. Arora, P. N., & Malhan, P. K. (Year). *Biostatistics*. Himalaya Publishing House
11. Pillai, R. S. N., & Bagavathi, V. (Year). *Statistics*. S. Chand and Co. Ltd.
12. Daniel, W. W., & Cross, C. L. (2019). Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley.
13. Daniel, W. W. (2010). Biostatistics: Basic Concepts and Methodology for the Health Sciences. Wiley.
14. Rosner, B. (2015). Fundamentals of Biostatistics. Cengage Learning.

Reference Distribution:

Module	Unit	Reference No.
	1.1	1
	1.2	2

1	1.3	1
	1.4	2
2	2.1	3
	2.2	4
3	3.1	5
	3.2	6
4	4.1	7
	4.2	8
	4.3	9
	4.4	10

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant
-

KU5DSCBIF301: MOLECULAR PHYLOGENETICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	Higher	KU5DSCBIF301	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course aims to understand the biological databases, sequence analysis, and molecular phylogeny. Students will explore different types of biological databases, submission protocols for sequences, sequence accuracy, and various file formats. Additionally, the course covers sequence similarity concepts, sequence alignment methods, multiple sequence alignments (MSA), databases related to MSA, and molecular phylogeny principles. Practical applications and tools for phylogenetic analysis are also discussed.

COURSE OBJECTIVES:

- Understand the structure and types of biological databases and their pitfalls
- Learn the submission process for sequences, assess sequence accuracy, and explore different file formats for bio-molecular sequences.
- Define sequence similarity, identity, homology, and understand concepts like homologous, orthologous, paralogous, analogous, and xenologous sequences.
- Gain an overview of sequence alignment methods and assess their significance in biological research.
- Explore multiple sequence alignment techniques, databases related to MSA, and tools for analyzing genomic DNA alignments.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To Demonstrate proficiency in accessing, retrieving information from biological databases and to apply sequence submission protocols and evaluate sequence accuracy for database submission.
CO2	To analyse the different concepts in sequence analysis.
CO3	To Utilize multiple sequence alignment techniques and tools for analyzing genomic DNA alignments.
CO4	To Interpret phylogenetic trees and understand their implications for evolutionary relationships

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4				√

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to biological databases: database, types of databases. Biological databases, pitfalls of biological databases, information retrieval from biological databases. 1.2 submission of sequences to the databases, sequence accuracy, computer storage of sequences. various file format for Bio-molecular Sequences: GenBank, FASTA, GCG, GCGMSF, PIR, Clustal, Swiss-prot. 1.3 Basic concept of sequence similarity, identity and homology, Definition of homologous, orthologous, paralogous, analogous, xenologous. 1.4 Definition, overview and significance of sequence alignment. Accessing the significance of sequence alignment.	**12**
Module 2	2.1 Multiple Sequence Alignment: typical uses and practical uses of MSA, 2.2 Five approaches to MSA- Exact Approaches to MSA, Progressive Sequence Alignment, Iterative Approaches, Consistency-Based approaches, Structure-Based Methods. 2.3 Databases of Multiple Sequence Alignment: Pfam, SMART, CDD, INTERPRO, iPROclass 2.4 Multiple Sequence Alignments of Genomic Regions: Analyzing Genomic DNA Alignments via UCSC, Analyzing Genomic DNA Alignments via Ensemble.	**13**
Module 3	3.1 Molecular Phylogeny and Evolution: Introduction to Molecular Evolution, Principles of Molecular Phylogeny and Evolution, Goals of Molecular Phylogeny, Historical Background. 3.2 Molecular Clock Hypothesis, Positive and Negative Selection. 3.3 Molecular Phylogeny: Properties of Trees, Topologies and Branch Lengths of Trees, Tree Roots. Enumerating Trees and Selecting Search Strategies. 3.4 Type of Trees, Species Trees versus Gene/Protein Trees, DNA, RNA, or Protein-Based Trees.	**18**
Module 4	4.1 Five Stages of Phylogenetic Analysis. 4.2 Tools and softwares for phylogenetics analysis.	**12**
Module 5	**Teacher Specific Module** *Directions*	**5**

Essential readings:

1. Pevsner, J. (2015). Bioinformatics and Functional Genomics (3rd ed.). John Wiley Sons.
2. Yang, Z. (2006). Computational Molecular Evolution. Oxford University Press

Suggested readings:

3. Pevsner, J. (2015). Bioinformatics and Functional Genomics (3rd ed.). John Wiley Sons.

4. Altschul, S. F., Gish, W., Miller, W., Myers, E. W., & Lipman, D. J. (1990). Basic local alignment search tool. Journal of Molecular Biology, 215(3).

5. Pearson, W. R. (2013). An introduction to sequence similarity ("homology") searching. Current Protocols in Bioinformatics, 42(1).

6. Thompson, J. D., Higgins, D. G., & Gibson, T. J. (1994). CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. Nucleic Acids Research, 22(22).

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	1
	1.3	2
	1.4	3
2	2.1	2
	2.2	4
	2.3	3
	2.4	4
3	3.1	4
	3.2	5
	3.3	6
	3.4	6
4	4.1	6
	4.2	6

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:
- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU5DSCBIF302: BIOINFORMATICS DATABASES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	Higher	KU5DSCBIF302	4	75

Learning Approach (Hours/ Week)			Marks Distribution			
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	Duration of ESE (Hours)
3	1	-	25	75	100	2

COURSE DESCRIPTION:

This course provides an introduction to bioinformatics, covering its history, goals, applications, and the nature of biological data types. Students will explore available bioinformatics resources on the web, primary resource institutes like NCBI, EMBL, and DDBJ, and the hierarchy of biological databases and practical course focuses on utilizing bioinformatics tools and databases for literature mining, sequence retrieval, pathway analysis, sequence alignment, and structural analysis in molecular biology. Students will learn to navigate and effectively utilize the literature resource platforms, BLAST programs, FASTA, and multiple sequence alignment tools like CLUSTAL W and T-COFFEE.

COURSE OBJECTIVES:

- To Understand the history, goals, and applications of bioinformatics, including its role in analyzing biological data.

- To Explore available bioinformatics resources on the web and understand how to navigate and utilize them effectively.
- To Learn about primary resource institutes in bioinformatics and their contributions to biological data management.
- To Understand the hierarchy of biological databases, including primary, secondary, and derived databases, and their relationships.
- To Gain hands-on experience with biological databases, tools for sequence analysis, molecular visualization, and similarity searches.

- students will have gained practical skills in utilizing a wide range of bioinformatics tools and databases essential for molecular biology research, literature analysis, sequence analysis, and structural biology investigations.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Students will be able to explain the history and goals of bioinformatics and its importance in modern biological research

CO2	Students will demonstrate proficiency in using bioinformatics resources available on the web for data retrieval and analysis.
CO3	Students will understand the role of primary resource institutes like NCBI, EMBL, and DDBJ in managing biological data and making it accessible to researchers worldwide.
CO4	Students will be able to navigate and utilize biological databases effectively, including database search engines, nucleic acid databases, protein sequence databases, and structural databases.
CO5	Students will gain practical skills in sequence analysis concepts, including alignment algorithms, scoring matrices, similarity searches, multiple sequence alignment, and motif analysis using various bioinformatics tools and databases.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3	√			
CO 4			√	
CO 5				√

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Bioinformatics: History, definition, goals, aims, applications, fields related to bioinformatics. Nature of biological data types 1.2 Overview of available Bioinformatics resources on the web 1.3 Primary Resource Institutes: NCBI, EMBL & DDBJ 1.4 Hierarchy of Biological databases: Primary, Secondary & Derived	12
Module 2	2.1 Biological databases & tools: Database search engines- Entrez, SRS. Nucleic acid databases- GenBank, ENA. 2.2 Protein sequence databases: NCBI Protein, EMBL Protein, PIRPSD, SwissProt/ UniProtKB/ TrEMBL, Expasy. Structural Databases: PDB, SCOP, CATH, NDB, CCSD. 2.3 Molecular visualization tools: RasMol, Cn3D, SPDBV, Chime, pymol 2.4 Databases and search methods for chemical compounds: PubChem Compound, PubChem Substance, ChEBI, ChEMBL, PDBeChem. Sequence Submission Tools: Sequin, BankIt, ENA, IMGT/HLA, Metagenomics	14

Module 3	3.1 Sequence analysis concepts: Local & Global alignment, DotPlot, Gap Penalties 3.2 Dynamic Programming, Heuristic Methods 3.3 Pairwise Sequence Alignment algorithms: Needleman & Wunsch, Smith & Waterman 3.4 Scoring matrices for Nucleic acids and proteins: PAM, BLOSUM	**13**
Module 4	4.1 Similarity searches: BLAST & FASTA, Other Tools: LALIGN, Dotlet. 4.2 Multiple Sequence Alignment: ClustalW, ClustalX, PRAS Other Tools: DbClustal, Kalign, MAFFT, MUSCLE, MView, TCoffee 4.3 Motifs, Pattern & Profiles 4.4 Derived Databases: PROSITE, BLOCK, ProDom, Pfam, PRINTS, SBASE	**12**
Module 5	**LABORATORY EXPERIMENTS** 01. Literature mining using pubmed central 02. Literature mining using Medline/pubmed 03. Introduction of NCBI, EMBL, DDBJ 04. Browse the ExPASY sites and write information received in your record 05. To retrieve metabolic pathways using KEGG PATHWAY Database 06. To retrieve metabolic pathway using REACTOM 07. Retrieving protein and DNA sequences using Entrez at NCBI 08. Retrieving protein and DNA sequences using SRS at EBI 09. Web browsing at PIR PSD 10. Web browsing at UNIPROT 11. Nucleotide BLAST - BLASTN programs search nucleotide databases using a nucleotide query. 12. Protein BLAST - BLASTP programs search protein databases using a protein query. 13. BLAST-X - BLASTX programs search protein databases using a Translated nucleotide query 14. FASTA – To provides sequence similarity searching against protein databases using the FASTA suite of programs 15. EMBOSS Needle - To Create an optimal global alignment of two sequences using the Needleman-Wunsch algorithm 16. EMBOSS Water – To Use the Smith-Waterman algorithm to calculate the local alignment of two sequences.	

Essential readings:

1. Durbin, R., Eddy, S. R., Krogh, A., & Mitchison, G. (1998). Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.
2. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
3. Introduction to Bioinformatics by Attwood, T.K. & Parry-Smith, D.J.(2001) Delhi, Pearson Education (Singapore) Pte.Ltd.

4. Rastogi, S.C., Mendiratta, N. and Rastogi, P. (2004) Bioinformatics: Concepts, Skills & Applications. CBS Publishers & Distributors, New Delhi

Suggested readings:

5. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
6. Lesk, A. M. (2017). Introduction to Bioinformatics. Oxford University Press.
7. Higgins, D., & Taylor, W. (2000). Bioinformatics: Sequence, Structure and Databanks. Oxford University Press.
8. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Wiley-Blackwell.
9. Rastogi, S.C., Mendiratta, N. and Rastogi, P. (2004) Bioinformatics: Concepts, Skills & Applications. CBS Publishers & Distributors, New Delhi.
10. Mount, David (2004). Bioinformatics: Sequence and Genome Analysis, New York, Cold Spring Harbor Laboratory Press.
11. Setubal, J. and Meidanis, J. (1996) Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	1
	1.4	1
2	2.1	2
	2.2	3
	2.3	4
	2.4	3
3	3.1	5
	3.2	4
	3.3	6
	3.4	7
4	4.1	9
	4.2	8
	4.3	10
	4.4	11

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T + 15P)**
Continuous Evaluation (CCA)		**35 (25T + 10P)**
THEORY		**25**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	5
d)	Viva-Voce	5

PRACTICAL		10
a)	Performance	4
b)	Record	4
c)	Punctuality	2
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU5DSEBIF303: STRUCTURAL BIOINFORMATICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	Higher	KU5DSEBIF303	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course aims to provide the principles of protein structure and nucleic acids, covering topics such as amino acid structure and classification, protein structure organization, DNA/RNA structure and types of base pairing, molecular interactions involving proteins and nucleic acids, and prediction methods for protein structure at different levels.

COURSE OBJECTIVES:

- Understand the fundamental principles of protein structure, including amino acid composition, classification, and structural motifs.
- Explore the structural organization of proteins at different levels as well as the methods used for predicting protein structures.
- Investigate molecular interactions involving proteins, DNA, and small molecules, including protein-protein interactions, protein-DNA interactions, and DNA binding

proteins
- Learn about prediction tools and methods for determining primary, secondary, and tertiary protein structures, as well as techniques for 3D structure comparison and classification using various databases.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Demonstrate a comprehensive understanding of protein structure principles, including amino acid properties and protein classification.
CO2	Analyze the structural organization of proteins and nucleic acids, including their primary, secondary, tertiary, and quaternary structures.
CO3	Apply knowledge of base pairing in DNA and RNA to understand their structural diversity and functional implications.
CO4	Evaluate molecular interactions involving proteins, DNA, and small molecules, and their significance in biological processes.
CO5	Utilize prediction tools and methods to predict and analyze protein structures at various levels and compare 3D structures using databases and structural classification systems.

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Principles of protein structure – amino acid group, structure, one-letter code, triplet code. 1.2 Classification of proteins – structure, composition, functions. Dihedral angle, Ramachandran plot. 1.3 Structural organization of protein - primary, secondary, tertiary and quaternary structures, motifs and domains. 1.4 Fundamentals of the methods for 1D,2D,3D structure prediction.	**14**
Module 2	2.1 DNA and RNA, types of base pairing - Watson-Crick and Hoogstein, 2.2 Different structural forms of DNA - A, B, Z and their geometrical as well as structural features. 2.3 Types of RNA - structural, geometrical parameters of each and their comparison. 2.4 Denaturation and renaturation of DNA	**13**
Module 3	3.1 Molecular interactions: Protein – protein interaction, protein-DNA interaction, DNA binding proteins. 3.2 Protein-Carbohydrates, Protein-Drug or Small molecule interactions. Metalloprotein, Sequence and structure-based methods to predict protein-protein interaction. 3.3 Types of interaction of DNA with protein and small molecule, different forces involved in the interactions. 3.4 Stereochemistry of proteins and nucleic acids.	**14**

Module 4	4.1 Primary structure prediction tools and softwares. 4.2 Secondary structure prediction using Chou Fasman, GOR methods and tools. 4.3 Tertiary structure prediction - Homology Modeling (different steps), fold recognition, ab-initio methods and tools (software's). 4.4 3-D structure comparison and concepts: FSSP, VAST and DALI, Fold Classes. Databases of structure-based classification: CATH, SCOP and PDB.	**14**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2020). *Molecular biology of the cell* (7th ed.). Garland Science.
2. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). *Bioinformatics: Methods and applications*. PHI Learning Pvt. Ltd
3. Xiong, J. (2006). *Essential bioinformatics*. Cambridge University Press.

Suggested readings:

4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular biology of the gene* (7th ed.). Pearson Education, Inc.
5. Berman, H. M., Westbrook, J., Feng, Z., Gilliland, G., Bhat, T. N., Weissig, H.,& Bourne, P. E. (2000). The Protein Data Bank. Nucleic Acids Research, 28(1).
6. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, *Molecular biology of the cell* P. (2020). (7th ed.). Garland Science.
7. Attwood, T. K., & Parry-Smith, D. J. (1999). *Introduction to bioinformatics*. Pearson Education.
8. Bourne, P. E., & Weissig, H. (2003). *Structural bioinformatics*. Wiley.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	2
	1.4	1
2	2.1	2
	2.2	3
	2.3	4
	2.4	4
3	3.1	5
	3.2	5
	3.3	6
	3.4	6
4	4.1	7
	4.2	8
	4.3	7
	4.4	8

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant

KU5DSEBIF304: DATABASE MANAGEMENT SYSTEM

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	Higher	KU5DSEBIF304	4	75

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3	1	0	25	75	100	2

COURSE DESCRIPTION:

This course provides a comprehensive introduction to the field of database systems. It covers the fundamental concepts of databases, including their applications, purposes, and architectural views. Students will explore data abstraction, instances and schemas, and various data models. The course delves into database languages, including Data Definition Language (DDL) and Data Manipulation Language (DML), and their usage in application programs. It also covers the roles of database users and administrators, transaction management, and database architecture, focusing on the storage manager and query processor.

Course Prerequisite: NIL

COURSE OUTCOMES:

CO1	Students will learn to design databases using ER diagrams, understand entities, attributes, entity sets, and relationships
CO2	Students will study relational query languages and operations, including relational algebra and calculus. They will learn to write SQL queries, perform set operations, use aggregate functions, and work with nested subqueries, views, and triggers.
CO3	Students will understand the principles of normalization and be able to normalize databases up to the fifth normal form. They will learn to identify and resolve functional, multi-valued, and join dependencies to ensure data integrity and reduce redundancy.
CO4	Students will gain insights into database architecture, including the roles of the storage manager and query processor. They will learn to manage transactions effectively, ensuring atomicity, consistency, isolation, and durability (ACID properties) in database operations

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1		√		
CO 2			√	
CO 3	√			
CO 4		√		

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction – purpose of Database systems. View of Data, Data Models, transaction management, database structure, DBA, Data Base Users. 1.2 E-R model, Basic concepts; design issues; Mapping Constraints; Keys; Primary, Foreign, candidate, E-R diagram; Weak entity set; Extended E-R features.	**14**
Module 2	2.1 Normal forms – 1NF, 2NF, 3NF and BCNF; functional dependency, Normalization 2.2 Introduction to the Relational Model – Structure – Database Schema, Keys – Schema DiagramS	**16**
Module 3	3.1 SQL: database languages; DDL- create, alter, drop; DML-Insert , Select, update, Delete; DCL ,TCL,SQL Functions, 3.2 Data types in SQL; Creation and deletion of database and user .Developing queries and sub queries. 3.3 Integrity constraints, views, Trigger and Sequences, Relational model – Structure of Relational database. Relational Algebra; Fundamental operations; Relational calculus; Tuple and domain calculus	**15**

Module 4	**LABORATORY EXPERIMENTS** 1. Create a multi-level data abstraction diagram (physical, logical, and view levels) for a small database system (e.g., library management system). 2. Design an ER diagram for a university database, including entities like Student, Course, Instructor, and Department. Identify attributes and relationships. 3. Enhance the university ER diagram by adding mapping constraints and keys (primary, foreign, and candidate keys) 4. Convert the university ER diagram into a relational schema. Create tables with appropriate primary and foreign keys. 5. Create a schema diagram for the relational schema of the university database, including tables and relationships. 6. Write SQL scripts to insert, update, select, and delete data in the university database tables. 7. Write SQL queries using aggregate functions (SUM, AVG, COUNT, MAX, MIN) and string functions (UPPER, LOWER, CONCAT). 8. Create and manage views. Write queries to retrieve data from views and demonstrate updating views.	**30**

Essential readings:

1. Date, C. J. (2004). An Introduction to Database Systems (8th ed.). Addison-Wesley

2. Elmasri, R., & Navathe, S. B. (2015). Fundamentals of Database Systems (7th ed.). Pearson

Suggested readings:

3. Ramakrishnan, R., & Gehrke, J. (2003). Database Management Systems (3rd ed.). McGraw-Hill

4. Connolly, T., & Begg, C. (2015). Database Systems: A Practical Approach to Design, Implementation, and Management (6th ed.). Pearson

5. Ullman, J. D., & Widom, J. (2008). A First Course in Database Systems (3rd ed.). Pearson

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
2	2.1	3,4
	2.2	2
3	3.1	5
	3.2	3,4
	3.3	2,4
4	4	5

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T + 15P)**
Continuous Evaluation (CCA)		**35 (25T + 10P)**
THEORY		**25**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	5
d)	Viva-Voce	5
PRACTICAL		**10**
a)	Performance	4
b)	Record	4
c)	Punctuality	2
Total		**100**

Employability for the Course:

- IT Analyst
- Research and Development Assistant
- Teaching
- Database Analyst
- Technical/ Project Assistant
- IT companies
- Web developer

KU5DSEBIF305: GENETICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	Higher	KU6DSEBIF305	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course provides a comprehensive introduction to the principles of genetics, covering topics ranging from basic genetic terminology and Mendelian inheritance to advanced concepts such as gene interactions, linkage, sex-linked inheritance, chromosomal aberrations, and gene

mutations. Students will explore the molecular basis of inheritance, genetic variation, and the application of genetic principles in various fields.

COURSE OBJECTIVES:

- To introduce students to essential genetic concepts, including genes, alleles, genotypes, and phenotypes, and their roles in heredity.
- To examine Gregor Mendel's work on inheritance, including his experimental procedures, observations, and the laws of inheritance derived from his experiments.
- To elucidate Mendelian inheritance patterns through monohybrid and dihybrid crosses, including the law of dominance, segregation, and independent assortment.
- To explore allelic gene interactions such as complete dominance, incomplete dominance, codominance, penetrance, expressivity, and pleiotropism.
- To delve into advanced genetic concepts such as genic interactions, epistasis, multiple alleles, linkage, crossing over, sex-linked inheritance, chromosomal aberrations, gene mutations, and population genetics principles such as the Hardy-Weinberg equilibrium.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Understand the basics of genetics and Mendel's law of inheritance.
CO2	Understand the allelic and non-allelic gene interactions.
CO3	Understand the characters and features of multiple alleles.
CO4	Understand the concepts linkage, crossing over of genes and sex-linked inheritance
CO5	Understand the concept of chromosomal abnormalities, population genetics

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4			√	
CO 5		√		

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Genetics – gene, allele, homozygote, heterozygote, hybrid, heredity, genotype, phenotype 1.2 Mendel's work – selection of experimental plant, procedure, experimental observations and results, 1.3 Monohybrid and di-hybrid crosses, law of dominance, law of segregation, law of independent assortment, back cross, test cross. 1.4 Allelic gene interactions: Complete dominance, incomplete dominance, codominance, penetrance, expressivity, pleiotropism, multiple genes/polygenes.	**14**
Module 2	2.1 Genic interactions: Non-allelic gene interactions – Complementary genes/duplicative recessive genes, 2.2 supplementary genes/non-epistatic interactions, 2.3 duplicate genes/ duplicative dominant genes, duplicate genes with cumulative effect. 2.4 Epistasis – dominant epistasis, recessive epistasis, Lethal genes – in man, mice and plants, atavism or reversion.	**13**
Module 3	3.1 Multiple alleles – coat colour in rabbits, blood group inheritance in man (ABO and Rh-antigen) and applications 3.2 Linkage - Types of linkage: complete and incomplete linkage - theories and factors affecting linkage. Linkage groups, importance of linkage. 3.3 Crossing over - types of crossing over, mechanism and theories of crossing over, factors affecting crossing over, significance of crossing over 3.4 two-point cross, three-point cross, linkage map.	**14**
Module 4	4.1 Sex linked genes and its inheritance, inheritance of X linked genes: colour blindness, haemophilia, of Y- linked genes, of XY-linked genes. 4.2 Sex limited genes, sex influenced genes, holandric genes, criss-cross inheritance, sex linked lethal genes. 4.3 Numerical and structural chromosomal aberrations – Euploidy, Aneuploidy, Nondisjunction in autosomes and sex chromosomes (example from human). 4.4 Different types of gene mutations - mutagens, Population genetics – Hardy-Weinberg equilibrium, gene pool, gene frequencies and genotype frequencies.	**14**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

1. Gardner, E. J., & Snustad, D. P. (2018). *Principles of Genetics*. Wiley.

2. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E., & Silver, L. M. (2017). *Genetics: From genes to genomes* (6th ed.). McGraw-Hill Education.

Suggested readings:

3. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E., & Silver, L. M. (2017). *Genetics: From genes to genomes* (6th ed.). McGraw-Hill Education

4. Strickberger, M. W. (2008). *Genetics* (3rd ed.). Prentice Hall of India

5. Sinnott, E. W., Dunn, L. C., & Dobzhansky, T. (1958). *Principles of genetics*. McGraw-Hill Education

6. Gardner, E. J., & Snustad, D. P. (2018). *Principles of genetics*. Wiley

7. Verma, P. S., & Agarwal, V. K. (2017). *Genetics*. S. Chand Publishing

8. Snustad, P., & Simmons, M. J. (2012). *Principles of genetics* (8th ed.). Wiley.

9. Strickberger, M. W. (2008). *Genetics* (3rd ed.). Prentice Hall of India Pvt. Ltd.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	1
	1.3	1
	1.4	2
2	2.1	2
	2.2	1
	2.3	3
	2.4	2
3	3.1	4
	3.2	3
	3.3	5
	3.4	6
4	4.1	7
	4.2	9
	4.3	6
	4.4	8

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians

- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU6DSCBIF306: GENOMICS AND PROTEOMICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	Higher	KU6DSCBIF306	4	75

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3	1	-	25	75	100	2

COURSE DESCRIPTION:

This course introduces the basic understanding of genomics, proteomics, and their applications in various scientific domains. Students will explore nucleotide sequence databases, genetic mapping techniques, DNA sequencing methods, proteomics tools, comparative genomics, and emerging fields like transcriptomics and epigenomics. The course integrates theoretical knowledge with practical applications, fostering a comprehensive understanding of cutting-edge techniques in molecular biology.

COURSE OBJECTIVES:

- Understand the fundamentals of genomics, including nucleotide sequence databases, genetic mapping, and DNA polymorphism

- Explore advanced techniques in DNA sequencing, such as the Sanger method and shotgun sequencing

- Gain proficiency in proteomics tools and techniques like 2-D gel electrophoresis, mass spectrometry, and protein microarrays

- Analyze comparative genomics concepts, including whole genome alignments and synteny comparisons

- Investigate emerging fields like transcriptomics and epigenomics, understanding their significance in molecular biology research.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To utilize nucleotide sequence databases for genomic analysis and identification and apply genetic mapping techniques.
CO2	To perform DNA sequencing using various methods and analyze sequencing data
CO3	To Conduct proteomics experiments, analyze protein expression profiles, and interpret mass spectrometry results
CO4	To Explore transcriptomics data to identify candidate genes and understand gene expression regulation
CO5	To Discuss the challenges and opportunities in epigenomics research, particularly in clinical and plant applications

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1			√	
CO 2	√			
CO 3			√	
CO 4			√	
CO 5		√		

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Genomics: introduction, Nucleotide sequence Databases, its Analysis and Identification, Goals of the Human Genome Project, 1.2 concept of maps, physical maps, shotgun libraries, genetic mapping, types of genetic mapping. 1.3 Genetic markers, application of genetic markers, application of gene mapping, DNA polymorphism, SNP, DNA typing. Cytogenetics, chromosome painting, FISH, 1.4 Isolation of genes from genomic DNA, cDNA, exon trapping, chromosome walking, gene prediction, transgenes, DGGE in mutation detection.	13
Module 2	2.1 DNA sequencing methods, sequencing strategies, Maxam-gilbert method. 2.2 Sanger method, in situ hybridization and its applications 2.3 Southern blotting, Northern blotting and its applications 2.4 short gun method, DNA micro array, working of micro array, applications.	12

Module 3	3.1 Proteomics: definition, types of proteomics, Proteomics classification; Tools and techniques in proteomics. 3.2 2-D gel electrophoresis, gel filtration, PAGE, isoelectric focusing, affinity chromatography, HPLC. 3.3 Mass spectroscopy for protein analysis, MALDI-TOF, Electrospray ionization (EST), Tandem mass spectroscopy (MS/MS) analysis; 3.4 peptide fingerprinting (PMF). Protein Micro array in protein expression, profiling and diagnostics, drug target discovery.	**15**
Module 4	4.1 Comparative genomics: Basic concepts and applications, whole genome alignments: understanding the significance; BLAST2, MegaBlast algorithms. 4.2 Applications of suffix tree in comparative genomics, synteny and gene order comparisons Comparative genomics databases: COG	**10**
Module 5	**LABORATORY EXPERIMENTS** 01. Identify the physio-chemical properties of a sequence 02. Sequence similarity searching 03. Multiple sequence alignment using open-source tools 04. Phylogenetic analysis & evolutionary relationship using offline tools 05. Predict the secondary structure of protein 06. Predict the tertiary structure of protein 07. Structure refining and validating the newly builded protein. 08. Predict the protein structure by ALPHAFOLD 09. Predict the protein cleavage sites and hydropathy plots 10. Predict the post translational modification of protein 11. Predict the disordered regions of protein 12. Comparison of protein with a genomic DNA sequence, protein to protein sequence 13. Visualize the structure with RASMOL. 14. Download protein and DNA from PDB and display using above program and analyse the structural features 15. RNA Secondary structure prediction.	**25**

Essential readings:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.
2. Brown, T. A. (2019). Genomes (4th ed.). Oxford University Press
3. Schuster, S. C. (2008). Next-generation sequencing transforms today's biology. Nature Methods

Suggested readings:

4. Attwood, T. K., & Parry-Smith, D. J. (1999). *Introduction to bioinformatics*. Pearson Education
5. Claverie, J.-M., & Notredame, C. (2003). *Bioinformatics: A beginner's guide*. John Wiley &

Sons.

6. Bourne, P. E., & Weissig, H. (2003). *Structural bioinformatics*. Wiley

7. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). *Bioinformatics: Methods and applications*. PHI Learning Pvt. Ltd.

8. Xiong, J. (2006). *Essential bioinformatics*. Cambridge University Press

9. Mount, D. W. (2004). *Bioinformatics: Sequence and genome analysis* (2nd ed.). Cold Spring Harbor Laboratory Press

10. Baxevanis, A. D., & Ouellette, B. F. F. (2005). *Bioinformatics: A practical guide to the analysis of genes and proteins* (3rd ed.). John Wiley & Sons..

11. Fersht, A. (1999). *Structure and mechanism in protein science: A guide to enzyme catalysis and protein folding*. W. H. Freeman.

12. Lutz, S., & Bornscheuer, U. T. (2009). *Protein engineering handbook* (Vol. 1). Wiley-VCH

13. Lesk, A. M. (2004). *Introduction to protein science: Architecture, function, and genomics*. Oxford University Press.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	2
	1.2	3
	1.3	3
	1.4	2
2	2.1	1
	2.2	10
	2.3	11
	2.4	12
3	3.1	13
	3.2	12
	3.3	14
	3.4	10
4	4.1	7
	4.2	8,12
	4.3	9,13
	4.4	10

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T + 15P)**
Continuous Evaluation (CCA)		**35 (25T + 10P)**
THEORY		**25**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	5
d)	Viva-Voce	5

PRACTICAL		10
a)	Performance	4
b)	Record	4
c)	Punctuality	2
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU6DSCBIF307: PROTEIN BIOINFORMATICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	Higher	KU6DSCBIF307	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	-	30	70	100	2

COURSE DESCRIPTION:

This course delves into the intricate processes of protein folding and stability, exploring the relationship between protein structure and function. It covers both theoretical and experimental approaches to protein folding, including determinants, pathways, and the role of folding accessory proteins. Students will learn about conformational diseases and the factors contributing to protein stability and denaturation, with a focus on thermostable proteins

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	able to explain the theory and experimental aspects of protein renaturation, folding pathways, and the role of folding accessory proteins
CO2	able to explain the stability of thermostable proteins and discuss the implications of protein stability in conformational diseases

CO3	proficient in strategies for protein design, including the use of protein expression, mutagenesis, and unnatural amino acids. They will be able to apply these techniques to enhance protein stability and design functional enzymes
CO4	able to apply geometric and stereochemical principles in designing proteins and analyze case studies of computationally designed proteins.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1			√	
CO 2	√			
CO 3			√	
CO 4			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Protein Folding and stability: Protein structural features, protein structure-function relationship. 1.2 Protein Folding: Theory and Experiment Protein Renaturation, Determinants of Protein Folding, Folding Pathways, Folding Accessory Proteins. 1.3 Introduction to Conformational Diseases. Protein stabilising factors, Protein Denaturation, Explaining the Stability of Thermostable Proteins	**15**
Module 2	2.1 Strategies for Protein Design: Introduction to protein expression and mutagenesis. 2.2 Protein engineering using unnatural amino acids- methodologies; applications-enhanced stability, enzyme design	**15**
Module 3	3.1 Computational Protein Design: Methods of Computational Protein Design, core and full repacking, predicting native protein core sequences; altering protein folds. 3.2 Geometry and stereochemistry-based design, Case studies on Computationally Designed Proteins	**15**

Module 4	4.1 Engineering artificial metalloenzymes, engineered cytochromes P450 for Biocatalysis, 4.2 Application of engineered biocatalysts for the synthesis of active pharmaceutical ingredients, Engineering antibody-based therapeutics: progress and opportunities,	**15**

Essential readings:

1. Zhao,H. (2021) Protein Engineering: Tools and Applications, Wiley-VCH Verlag GmbH & Co
2. Carey, P.R. (1996) Protein Engineering and Design, 1/e, Academic Press Inc, USA

Suggested readings:

3. Samish,I. (2017). Computational Protein Design, 1/e, Humana Press, New York
4. Stefan, L. and Uwe, T.B. (Eds), (2012) Protein Engineering Handbook: Volume 3, 1/e, Wiley-VCH Verlag GmbH & Co
5. Park, S.J., and Cochran, J.R. (2010). Protein Engineering and Design, 1/e, Taylor and Francis Inc., CRC Press, USA

Reference Distribution:

Module		Unit	Reference No.
1		1.1	1
		1.2	2
		1.3	1,2
2		2.1	2
		2.2	2
3		3.1	3
		3.2	3,4
4		4.1	4,5
		4.2	4,5

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU6DSCBIF308: MOLECULAR MODELING AND SIMULATIONS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	Higher	KU6DSCBIF308	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course provides a comprehensive overview of molecular modeling techniques and their applications in drug design. Topics include molecular mechanics force fields, intramolecular and non-bonded interactions, energy minimization methods, advanced simulation techniques, simulation of large systems, and principles of drug design. Students will learn about molecular dynamics simulations, Monte Carlo methods, drug target classification, pharmacophore concepts, structure-based drug design, and the role of artificial intelligence in drug discovery and development.

COURSE OBJECTIVES:

- Understand molecular modeling principles, including coordinate systems, potential energy surfaces, and molecular mechanics force fields
- Explore intramolecular and non-bonded interactions
- Apply constraints, restraints, and coarse-grained approaches in molecular modeling, and assess the accuracy of force fields
- Implement energy minimization techniques like Steepest Descent and Conjugate Gradient and compare different optimization methods.
- Investigate advanced simulation techniques.

Course Prerequisite: Basic knowledge in biology

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To analyze molecular structures and interactions using molecular modeling techniques
CO2	To apply energy minimization methods to optimize molecular structures and assess their stability
CO3	To evaluate the accuracy and limitations of molecular mechanics force fields
CO4	To simulate large systems using boundary conditions, long-range interactions, and advanced simulation algorithms
CO5	To design and evaluate drug candidates based on ADMET properties, Lipinski's rule of 5, pharmacophore concepts, and structure-based drug design principles

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2				√
CO 3			√	
CO 4				√
CO 5		√		

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Molecular Modeling and Structure: Introduction to Molecular modelling, Coordinate systems, potential energy surfaces for simple molecules. 1.2 The simple molecular mechanics force field; general features of molecular mechanics force fields. 1.3 Force Fields and Molecular Representation – Intramolecular Interactions, Non-bonded Interactions –van der Waals Interactions, Electrostatic Interactions, Hydrogen Bonds. 1.4 Constraints and Restraints, United Atom and Other Coarse-Grained Approaches, Non-pairwise Interactions, accuracy of the force fields	**14**

Module 2	2.1 Energy Minimization and Related Analysis Techniques: Steepest Descent, Conjugate Gradient	**14**
	2.2 Newton Raphson, Comparison of Methods	
	2.3 Advanced Techniques: Simulated Annealing, Branch-and-bound, Simplex, Phase space, Liouville's theorem, Ensemble theory	
	2.4 Thermodynamic averages - Microcanonical Ensemble, Canonical Ensemble, Other MD Simulation Related Ensembles.	
Module 3	3.1 Methods for Simulating Large Systems: Non-bonded Cutoffs – Shifted Potential and Shifted Force.	**14**
	3.2 Boundaries – Periodic Boundary Conditions, Stochastic Forces at Spherical Boundary. Long-range Interactions – The Ewald Sum.	
	3.3 Molecular dynamics using simple models, Molecular dynamics with continuous potentials, finite difference and predictor-corrector integration methods, choosing the time step.	
	3.4 Implementation of the Metropolis Monte Carlo method; Monte Carlo simulation of rigid and flexible molecules.	
Module 4	4.1 Drug design: Introduction to drug designing, ADMET, drug metabolism, toxicity and pharmacokinetics.	**13**
	4.2 Lipinski rule of 5, Identification and validation strategies.	
	4.3 Drug Target classification, Concept of Pharmacophore, Functional group considered as pharmacophore, Structure-based drug design,	
	4.4 Docking, QSAR, Artificial intelligence in drug discovery and development	
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Leach, A. R. (2001). Molecular Modelling: Principles and Applications. Prentice Hal
2. Jensen, F. (2017). Introduction to Computational Chemistry. John Wiley & Sons

Suggested Readings:

3. Lipinski, C. A. (2004). Drug-like properties and the causes of poor solubility and poor permeability. *Journal of Pharmacological and Toxicological Methods*
4. Frenkel D. and Smit B. (2001). Understanding Molecular Simulation 2nd Edition, Academic Press
5. Bhatt, T. K., & Nimesh, S. (Eds.). (2021). The design and development of novel drugs and vaccines: Principles and protocols. Academic Press
6. Renaud, J. P. (Ed.). (2020). Structural biology in drug discovery: Methods, Techniques, and Practices. John Wiley & Sons
7. Allen, M. P., & Tildesley, D. J. (2017). Computer Simulation of Liquids 2nd Edition, Oxford University Press.
8. Alavi S. (2020). Molecular Simulations: Fundamentals and Practice 1st Edition, Wiley-VCH.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	3
	1.3	1
	1.4	2
2	2.1	3
	2.2	3
	2.3	4
	2.4	4
3	3.1	4
	3.2	2
	3.3	5
	3.4	6
4	4.1	8
	4.2	7
	4.3	5
	4.4	8

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Omics Data Analyst
- Technical/ Project Assistant
- Research Assistant
- Scientist at different grades

KU6DSEBIF309: MOLECULAR BIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	Higher	KU6DSEBIF309	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	-	30	70	100	2

COURSE DESCRIPTION:

This course provides an in-depth exploration of molecular biology focusing on the history, development, and fundamental aspects of nucleic acids as genetic materials. It includes the topics such as DNA replication mechanisms in prokaryotes and eukaryotes, types of replications, DNA damage and repair mechanisms, transcription processes, RNA processing, translation processes, and regulation of gene expression in both prokaryotes and eukaryotes.

COURSE OBJECTIVES:

- To Understand the historical development, significance of molecular biology, particularly focusing on nucleic acids as genetic materials and explore the nature of the genetic code and deciphering mechanisms.
- To Examine the processes and enzymes involved in DNA replication in prokaryotes and eukaryotes.
- To Investigate DNA damage and repair mechanisms with a focus on repair systems in prokaryotic and eukaryotic cells.
- Analyze transcription processes in prokaryotes and eukaryotes also the translation in prokaryotes and eukaryotes.
- To Explore the regulation of gene expression in prokaryotes through operons, negative and positive control mechanisms.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To Demonstrate a comprehensive understanding of the historical context and development of molecular biology, focusing on the genetic materials.
CO2	To Apply knowledge of the genetic code, including the wobble hypothesis, to decipher genetic information.

CO3	To Analyze and compare DNA replication processes in prokaryotes and eukaryotes, including different types of replications and the role of specific enzymes.
CO4	To Evaluate DNA damage and repair mechanisms, including their significance in maintaining genetic integrity and preventing mutations.
CO5	To Describe transcription and translation processes in both prokaryotes and eukaryotes, including post-transcriptional modifications and regulation of gene expression.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1		√		
CO 2		√		
CO 3		√		
CO 4		√		
CO 5				√

COURSE CONTENTS:

Module	Description	Teaching Hours
	1.1 History and development of Molecular biology- Nucleic acids - DNA and RNA as genetic materials	14
Module 1	1.2 Nature of genetic code- deciphering genetic code- wobbles hypothesis. 1.3 DNA replication in prokaryotes, DNA replication in eukaryotes. 1.4 Types of replications. Unit of replication, enzymes involved, replication origin and replication fork.	
Module 2	2.1 DNA damage and repair mechanisms- photo activation - excision repair- recombination repair, gene mutations- point, frame shift- physical and chemical mutagens, hotspot, oncogenes. 2.2 Mechanisms of DNA repair in prokaryotes and eukaryotes, 2.3 Excision repair, mismatch repair, recombination repair, error prone repair 2.4 Repair system in eukaryotic cells.	14

Module 3	3.1 Transcription in prokaryotes and eukaryotes - transcription unit, promoter, terminator sequence- RNA polymerases, 3.2 RNA processing - capping, splicing, polyadenylation, structure and functions of different types of RNA. 3.3 Role of enhancers, gene silencers, CpG Islands, post transcriptional modifications. 3.4 RNA splicing reactions, catalytic RNA, Regulatory RNA, Micro RNAs & RNA Interference	13
Module 4	4.1 Translation in prokaryotes and eukaryotes- aminoacylation of tRNA. Formation of initiation complex, elongation and elongation factors, termination. 4.2 gene, cistron, muton, polysome, one gene one polypeptide hypothesis. 4.3 Regulation of gene expression in prokaryotes- operons - negative and positive control - lac and trp operon. 4.4 catabolic repression, chromatin activity and gene regulation in eukaryotes	14
	Teacher Specific Module	5
Module 5	*Directions*	

Essential readings:
1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2020). *Molecular biology of the cell* (7th ed.). Garland Science.
2. Lewin, B. (2007). *Genes IX*. Jones and Bartlett Publishers.
3. Watson, J. D., & Baker, T. A. (2013). *Molecular biology of the gene*. Pearson.

Suggested readings:
4. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2019). *Essential cell biology* (5th ed.). Garland Science.
5. Karp, G. (2016). *Cell and molecular biology: Concepts and experiments*. John Wiley & Sons.
6. Watson, J. D., & Baker, T. A. (2013). *Molecular biology of the gene*. Pearson.
7. Bell, S. P., Gann, A., Levine, M., & Losick, R. (2003). *Molecular cell biology*. W. H. Freeman
8. Lewin, B. (2007). *Genes IX*. Jones and Bartlett Publishers.
9. Lodish, H., Berk, A., Matsudaira, P., Kaiser, C. A., Krieger, M., Scott, M. P., Zipursky, S. L., & Darnell, J. (2016). *Molecular cell biology*. W. H. Freeman & Co   *Molecular biology*
10. Clark, D. P., & Pazdernik, N. J. (2021). (4th ed.). Academic Press.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	4
	1.4	3
2	2.1	5
	2.2	7
	2.3	8
	2.4	5
3	3.1	7
	3.2	8
	3.3	8
	3.4	4
4	4.1	8
	4.2	7
	4.3	4
	4.4	6

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU6DSEBIF310: CYTOGENETICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	Higher	KU5DSEBIF310	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	-	30	70	100	2

COURSE DESCRIPTION:

This course provides an in-depth exploration of genome organization across different biological domains, including viruses, bacteria, animals, and plants. It covers the structural and functional aspects of nuclear and organellar genomes, offering insights into how genetic material is organized, maintained, and expressed. The course also examines the mechanisms of sex determination in various organisms, with a specific focus on plants, animals, and Drosophila, including the concept of dosage compensation.

Course Prerequisite: NIL
COURSE OUTCOMES:
Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Able to describe the structural organization of genomes in viruses, bacteria, animals, and plants, and explain how these structures influence genetic function and stability.
CO2	Learn the mechanisms of sex determination in plants, animals, and Drosophila, including the processes of dosage compensation
CO3	compare and contrast the organization and function of nuclear genomes with those of organellar genomes (mitochondrial and chloroplast genomes), understanding their unique features and evolutionary significance
CO4	Apply their knowledge of genome organization and sex determination to practical scenarios in biotechnology, agriculture, and medicine, developing problem-solving skills relevant to these fields
CO5	Critically evaluate current research and recent advances in genomics and molecular biology, staying updated with cutting-edge developments in genome organization and sex determination

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2			√	
CO 3		√		
CO 4			√	

COURSE CONTENTS:

Module	Description	Teaching Hours

Module 1	1.1 Chromosome structure, Organization: Chromatin structure, Nucleosomal and Higher order, Telomere and its maintenance. 1.2 Mitotic and Meiotic Chromosomes. Heterochromatin and euchromatin, 1.3 Special types of chromosomes – Polytene chromosome, Lamp-brush chromosome. B chromosome, Sex chromosome	16
Module 2	2.1 Chromosome Banding – (G, Q, C, R) and Painting, Karyotyping, 2.2 In-situ hybridization (FISH and GISH), 2.3 Somatic cell hybridization	14
Module 3	3.1 Extra Nuclear inheritance: Maternal inheritance, Mitochondrial, and Chloroplast, 3.2 Plasmids: Types, detection, replication, incompatibility, partitioning, copy number control and transfer. 3.3 Properties of some known plasmids	13
Module 4	4.1 Genome organization in viruses, bacteria, animals and plants. 4.2 Mechanisms of sex determination in plants, animals and Drosophila (Dosage compensation), 4.3 Organization of nuclear and organellar genomes	12
Module 5	**Teacher Specific Module**	5
	Directions	

Essential readings:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6th ed.). Garland Science.

2. Brown, T. A. (2017). **Genomes 4**. Garland Science

Suggested readings:
3. Lewin, B. (2008). **Genes IX**. Jones and Bartlett Publishers
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Amon, A. (2016). **Molecular Cell Biology** (8th ed.). W.H. Freeman.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	1
2	2.1	2
	2.2	2
	2.3	3
3	3.1	3
	3.2	3
	3.3	3
	4.1	4

	4.2	3
4	4.3	4

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

a. Lab Assistant
b. Research and Development Assistant
c. Teaching
d. Biological Technicians
e. Database Analyst
f. Technical/ Project Assistant
g. Research Assistant

KU7DSCBIF401: ADVANCED BIOINFORMATICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	Advanced	KU7DSCBIF401	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course provides an in-depth exploration of genetic engineering techniques and their applications in various fields. It covers fundamental concepts such as cloning, DNA labeling, DNA modifying enzymes, DNA ligase, host cells, vectors, cloning strategies, PCR methodology, selection and screening of recombinants, nucleic acid hybridization, and introduction to nanotechnology

COURSE OBJECTIVES:

- Understand the basics of genetic engineering, including cloning techniques, restriction enzymes, DNA labeling, and modifying enzymes.
- Familiarize students with different host cells, vectors, and cloning strategies used in genetic engineering.
- Develop practical skills in DNA manipulation, including transformation, transfection, and PCR methodology.
- Explore advanced techniques such as nucleic acid hybridization, screening protocols, and analysis of cloned genes.
- Investigate the applications of nanotechnology in biotechnology, medicine, agriculture, and potential ethical challenges.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To Demonstrate proficiency in using restriction enzymes for DNA manipulation, mapping and to perform DNA labeling techniques.
CO2	To Apply DNA modifying enzymes effectively in genetic engineering experiments
CO3	To Construct and analyze recombinant DNA molecules using host cells and vectors and to utilize PCR methodology for gene amplification and analysis
CO4	To Evaluate recombinant clones using selection, screening, and nucleic acid hybridization techniques
CO5	To Demonstrate knowledge of nanotechnology principles and its applications in various fields, including drug delivery and agriculture.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1			√	
CO 2				√
CO 3		√		
CO 4			√	
CO 5		√		

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Genetic Engineering: Basics of cloning: restriction enzymes – Type I, II and III, restriction modification systems, type II restriction endonucleases and properties, isoschizomers and neoschizomers. restriction mapping. 1.2 Labeling of DNA: Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase. 1.3 DNA modifying enzymes- nuclease, polymerases, enzymes that modify the ends of DNA molecules. 1.4 DNA ligase – joining DNA molecules.	**15**
Module 2	2.1 Host cells and vectors: host cell types-prokaryotic hosts, eukaryotic hosts. 2.2 Plasmid vector, bacteriophage vector, phage vectors, BAC, YAC, artificial chromosomes. Getting DNA into cells-transformation and transfection, packing phage DNA in vitro, alternative DNA delivery methods. 2.3 Cloning strategies: cloning from mRNA, cloning from genomic DNA, advanced cloning strategies. 2.4 History, methodology and applications of PCR.	**13**
Module 3	3.1 Selection, screening, and analysis of recombinants: Genetic selection and screening methods, Complementation of defined mutations, Other genetic selection methods 3.2 Screening using nucleic acid hybridisation-Nucleic acid probes, Screening clone banks. 3.3 Use of the PCR in screening protocols 3.4 Analysis of cloned genes-Characterisation based on mRNA translation *in vitro,* Restriction mapping, Blotting techniques, DNA sequencing	**13**
Module 4	4.1 Nanotechnology: Introduction to Nanotechnology, history and development of science. 4.2 fabrication of nanomaterials - Bottom up (building from molecular level) and top down (breakdown of microcrystalline materials) approaches. 4.3 Nano carriers for drug delivery, Nanoparticles for cancer drug delivery: cancer and current approaches to its cure through nanoparticles. 4.4 application of nanotechnology in agriculture, medicine and biotechnology & bioinformatics. possible military applications, ethical issues and challenges	**14**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014).

Molecular Biology of the Cell (6th ed.). Garland Science.
2. Whitesides, G. M. (2003). Nanoscience, nanotechnology, and chemistry.
3. Poole, C. P., & Owens, F. J. (2013). *Introduction to nanotechnology*. Wiley.

Suggested readings:
4. Ambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual (3rd ed.). Cold Spring Harbor Laboratory Press.
5. Poole, C. P., & Owens, F. J. (2013). *Introduction to nanotechnology*. Wiley
6. Old, R. W., & Primrose, S. B. (2001). *Principles of genetic manipulation* (6th ed.). Blackwell Science
7. Wilson, M., Smith, G., Simmons, M., & Raguse, B. (2005). *Nanotechnology: Basic science and emerging technologies*. Overseas Press
8. Poole, C. P., & Owens, F. J. (2003). *Introduction to nanotechnology*. Wiley Interscience
9. Diwan, P., & Bhardwaj, A. (2006). *Nano Medicines*. Pentagon Press.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	2
	1.2	2
	1.3	6
	1.4	6
2	2.1	6
	2.2	1
	2.3	3
	2.4	4
3	3.1	5
	3.2	7
	3.3	6
	3.4	4
4	4.1	2
	4.2	3
	4.3	8
	4.4	9

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant

- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU7DSCBIF402: COMPUTER AIDED DRUG DESIGN

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	Advanced	KU7DSCBIF402	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course provides an in-depth exploration of drug discovery and development processes, focusing on lead discovery methods, analog-based drug design, quantitative structure-activity relationship (QSAR) techniques, molecular modelling, virtual screening, informatics, and methods in drug design. Students will delve into the stages of drug discovery and development, rational approaches to lead discovery, QSAR principles, molecular modelling techniques, and the use of informatics tools in drug design.

COURSE OBJECTIVES:

- Understand the stages involved in drug discovery and development.
- Explore various rational approaches to lead discovery, including traditional medicine, random and non-random screening.
- Analyze analog-based drug design principles such as bioisosterism, classification
- Investigate quantitative structure-activity relationship (QSAR) concepts, including the history and development of QSAR, physicochemical parameters, experimental and theoretical determination methods.
- Utilize molecular modelling and virtual screening techniques, including pharmacophore mapping, molecular docking (rigid and flexible), de novo drug design.

Course Prerequisite: Basic knowledge in biology and computer

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To demonstrate a comprehensive understanding of the stages involved in drug discovery and development, from lead discovery to clinical trials

CO2	To apply rational approaches to lead discovery, including traditional medicine insights, screening methods, and observation-based lead identification
CO3	To evaluate analog-based drug design strategies through case studies and bioisosterism principles
CO4	To analyze quantitative structure-activity relationship (QSAR) models, including physicochemical parameters and QSAR modeling techniques
CO5	To utilize molecular modeling, virtual screening, and informatics tools to design and analyze potential drug candidates.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2				√
CO 3		√		
CO 4				√
CO 5		√		

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Drug Discovery and Development: Stages of drug discovery and development 1.2 Lead discovery and Analog Based Drug Design: Rational approaches to lead discovery based on traditional medicine, Random screening, Non-random screening 1.3 serendipitous drug discovery, lead discovery based on drug metabolism, lead discovery based on clinical observation. 1.4 Analog Based Drug Design: Bioisosterism, Classification.	**14**
Module 2	2.1 Quantitative Structure Activity Relationship (QSAR): SAR versus QSAR 2.2 History and development of QSAR 2.3 Types of physicochemical parameters, experimental and theoretical approaches for the determination of physicochemical parameters such as Partition coefficient, Hammet's substituent constant and Tafts steric constant. 2.4 Hansch analysis, Free Wilson analysis, 3D-QSAR approaches like COMFA and COMSIA.	**14**

Module 3	3.1 Molecular Modeling and virtual screening techniques: Virtual Screening Techniques-Drug likeness screening, 3.2 Concept of pharmacophore mapping and pharmacophore-based Screening. 3.3 Molecular docking: Rigid docking, flexible docking, manual docking, Docking based screening. 3.4 De novo drug design.	**15**
Module 4	4.1 Informatics & Methods in drug design: Introduction to Bioinformatics, Chemoinformatics. 4.2 ADME databases, chemical, biochemical and pharmaceutical databases. 4.3 Molecular Modeling: Introduction to molecular mechanics and quantum mechanics. 4.4 Energy Minimization methods and Conformational Analysis, global conformational minima determination.	**12**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Leach, A. R., & Gillet, V. J. (2007). An Introduction to Chemoinformatic. Springer Science & Business Media

2. Muegge, I., & Mukherjee, P. (2016). An overview of molecular fingerprint similarity search in virtual screening. *Expert Opinion on Drug Discovery*

Suggested Readings:

3. Wermuth, C. G. (Ed.). (2015). The Practice of Medicinal Chemistry (Fourth Edition). Academic Press

4. Gilson, M. K., & Zhou, H. X. (2007). Calculation of protein-ligand binding affinities. Annual Review of Biophysics and Biomolecular Structure

5. Lipinski, C. A., Lombardo, F., Dominy, B. W., & Feeney, P. J. (2001). Experimental and computational approaches to estimate solubility and permeability in drug discovery and development settings. Advanced Drug Delivery Reviews

6. *Young, D. C. (2009).* Computational Drug Design: A Guide for Computational and Medicinal Chemists *(1st ed.). Wiley & Sons, Inc*

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	1
	1.3	3
	1.4	3
2	2.1	2
	2.2	2
	2.3	3
	2.4	3
3	3.1	4
	3.2	4
	3.3	6
	3.4	5

4	4.1	5
	4.2	5
	4.3	6
	4.4	6

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Omics Data Analyst
- Technical/ Project Assistant
- Research Assistant
- Scientist at different grades

KU7DSCBIF403: CHEMINFORMATICS AND DRUG DISCOVERY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	Advanced	KU7DSCBIF403	4	75

Learning Approach (Hours/ Week)			Marks Distribution			
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	Duration of ESE (Hours)
3	1	-	25	75	100	2

COURSE DESCRIPTION:

This course provides a comprehensive overview of chemoinformatics and its applications in drug design. Students will learn about 2D and 3D molecular structure representations, molecular descriptors, computational models like QSAR, structure visualization tools, cheminformatics databases, drug classification, drug design methods, molecular docking, and

the drug development process. Emphasis will be placed on practical applications through hands-on exercises and case studies.

COURSE OBJECTIVES:

- To Understand the history, scope, and manipulation of 2D and 3D molecular structures in cheminformatics
- To Learn about molecular descriptors and computational models used in quantitative structure-activity relationship (QSAR) studies
- To Explore structure visualization tools and cheminformatics databases for drug design and analysis
- To Study different drug design methods, including structure-based design, ligand-based design, and de novo drug design
- To Gain insights into the drug development process, including clinical trials, drug administration routes, and pharmacokinetics/pharmacodynamics

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To Utilize computational tools to represent and manipulate molecular structures for chemoinformatics analysis
CO2	To Apply quantitative structure-activity relationship (QSAR) models to predict drug properties and interactions
CO3	To Evaluate structure visualization tools and cheminformatics databases for drug discovery and design
CO4	To Design and analyze drug molecules using structure-based and ligand-based approaches
CO5	To Understand the drug development process, including clinical trials, drug administration, and pharmacokinetics/pharmacodynamics

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1			√	
CO 2				√
CO 3			√	
CO 4				√
CO 5	√			

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to chemoinformatics: History, scope, representation and manipulation of 2D molecular structures - computer representations, structure and substructure searching, reaction databases. 1.2 representation and manipulation of 3D molecular structures – experimental and theoretical 3D databases, conformational search. 1.3 Molecular descriptors: 2D and 3D structure representations. 1.4 Computational models: Deriving a QSAR Equation: Simple and Multiple Linear Regression, Designing a QSAR "Experiment", Principal Components Regression, Partial Least Squares, Molecular Field Analysis and Partial Least Squares	**13**
Module 2	2.1 Structure visualization tools: Rasmol, SPDBV, pyMOL, Cn3D, VMD, chime. 2.2 Cheminformatics tools- chemical database-PUBCHEM, SMILES, DrugBank, Chembank	**10**
Module 3	3.1 Introduction to drugs, classification of drugs, characteristics of a drug, drug dosage and drug efficiency, rule of five. 3.2 structure-based drug design(SBDD). QSAR and 3D-QSAR Methods. Pharmacophore Design, Ligand-Based Design and De Novo Drug Design, Virtual screening/docking of ligands. Protein structure. 3.3 Drug action enzymes. Drug action receptors. Drug design target interaction. Prediction of Binding Modes, Protein–ligand binding free energies, Fragment-Based Drug Design; Absorption, Distribution, Metabolism, Excretion & Toxicology (ADMET) prediction; 3.4 Drug action: pharmaco-kinetics, pharmacodynamics, pharmacophore identification, structure and action of anti cancer drugs, anti-diabetic drugs, anti-inflammatory drugs and antibiotics.	**13**
Module 4	4.1 Introduction to the Process of drug development-clinical trials phase I, II, III and IV. Route of drug administration. Nature of cell membrane, physiological factors related to drug absorption and drug distribution. 4.2 Introduction to docking methods to generate new structure; Tools and Molecular docking programs: AutoDock, Vina, Hdock 4.3 Druggable Targets, Macromolecular modeling- Ab initio modeling; Phyre 2 server. Homology Modeling- Modeller. Threading- RAPTOR. 4.4 Validation of the Model – Ramachandran Plot. PROCHECK. Binding site; Q-Site finder, Catalytic site atlas. Molecular docking; ArgusLab, AutoDock, GLIDE. Drug-receptor interaction. Pymol, Rasmol viewer.	**14**

	PRACTICALS	
Module 5	01. Download protein and DNA from PDB and display using above program and analyse the features.	**25**
	02. Use visualization tools like RasMol, Swiss Pdb viewer and analyse structural features of the molecules. 03. Use visualization tools like cn3D, PyMol and analyse structural features of the molecules. 04. Model building of DNA, protein and organic molecules using the ISIS draw / CHEMSKETCH 05. Molecular docking using AUTODOCK/HEX/DOCK/AMBER and open-source tools 06. Model refinement and validation of a target protein 07. Energy minimization of the target protein 08. Predict the 3D structure of a molecule by ab-initio method 09. Predict the 3D structure of a molecule by homology modeling 10. Predict the drug likeliness and ADMET properties of the lead molecules. 11. Predict the binding site of the protein 12. Predict the disordered region of a target protein 13. Predict the structure classification and analysis of a macromolecular structure. 14. Predict and analyse the ligand based virtual screening using web tools.	

Essential readings:

1. Leach, A. R., & Gillet, V. J. (2007). An Introduction to Chemoinformatics. Springer Science & Business Media
2. Lipinski, C. A. (2004). Lead- and drug-like compounds: the rule-of-five revolution. Drug Discovery Today: Technologies
3. Walters, W. P., & Murcko, M. A. (2002). Prediction of 'drug-likeness'. Advanced Drug Delivery Reviews
4. Sali, A., & Blundell, T. L. (1993). Comparative protein modelling by satisfaction of spatial restraints. Journal of Molecular Biology

Suggested readings:

5. Attwood, T. K., & Parry-Smith, D. J. (1999). *Introduction to bioinformatics*. Pearson Education
6. Claverie, J.-M., & Notredame, C. (2003). *Bioinformatics: A beginner's guide*. John Wiley & Sons.
7. Bourne, P. E., & Weissig, H. (2003). *Structural bioinformatics*. Wiley
8. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). *Bioinformatics: Methods and applications*. PHI Learning Pvt. Ltd.
9. Mendiratta, N., & Rastogi, P. (Year). *Title of the Book*. Prentice-Hall of India Pvt. Ltd, New Delhi
10. Xiong, J. (2006). *Essential bioinformatics*. Cambridge University Press

11. Mount, D. W. (2004). *Bioinformatics: Sequence and genome analysis*. Cold Spring Harbor Laboratory Press

12. Baxevanis, A. D., & Ouellette, B. F. F. (2005). *Bioinformatics: A practical guide to the analysis of genes and proteins* (3rd ed.). John Wiley & Sons.

13. Fogel, G. B., & Corne, D. (2003). *Evolutionary computations in bioinformatics*. Morgan Kaufmann

14. Branden, C., & Tooze, J. (1999). *Introduction to protein structure*. Garland Science

15. Fersht, A. (1999). *Structure and mechanism in protein science: A guide to enzyme catalysis and protein folding*. W. H. Freeman

16. Creighton, T. E. (Ed.). (1992). *Protein folding*. W. H. Freeman.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	3
	1.2	15
	1.3	16
	1.4	16
2	2.1	2
	2.2	1
3	3.1	4
	3.2	3
	3.3	8
4	3.4	11
	4.1	13
	4.2	12
	4.3	7
	4.4	8

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T + 15P)**
Continuous Evaluation (CCA)		**35 (25T + 10P)**
THEORY		**25**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	5
d)	Viva-Voce	5
PRACTICAL		**10**
a)	Performance	4
b)	Record	4
c)	Punctuality	2
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU7DSCBIF404: BIOETHICS AND IPR

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	Advanced	KU7DSCBIF404	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course provides an in-depth understanding of Intellectual Property Rights (IPR) and their relevance in science and technology. It covers the fundamentals of IPR, including the definition, importance, and classification of tangible and intangible properties. Students will explore various types of intellectual property such as patents, copyrights, trademarks, industrial designs, and geographical indications. The course examines the significance of IPR in scientific and technological advancements and delves into international conventions and agreements related to IPR, including GATT and TRIPS. Indian IPR legislations and the scope of patents in both Indian and international contexts are also discussed.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Students will be able to define and explain the importance of intellectual property rights, differentiating between tangible and intangible properties
CO2	Students will gain knowledge about various types of intellectual property, including patents, copyrights, trademarks, industrial designs, and geographical indications, and their specific roles in protecting innovations
CO3	Students will understand the key international conventions related to IPR, such as GATT and TRIPS, and compare them with Indian IPR laws

CO4	Students will learn the criteria for patentability and distinguish between discovery and invention. They will evaluate patent laws from Indian and international perspectives and study landmark patent cases to understand their impact
CO5	Students will explore the basic principles of bioethics, particularly in genetic engineering and healthcare. They will identify and discuss ethical issues, biopiracy concerns, and biosafety requirements, focusing on the Biological Diversity Act, 2002, and other relevant biosafety laws in India

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1		√		
CO 2		√		
CO 3			√	
CO 4				√
CO 5			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 IPR Definition and importance, Tangible and Intangible Property 1.2 Classification of Intellectual Property-Patents, Copyright, Trademark, Industrial Design, Geographical Indications 1.3 Relevance of Intellectual Property Rights for Science and Technology	**16**
Module 2	2.1 International Conventions relating to Intellectual Property: General Agreement on Trade and Tariff 2.2 Trade Related Aspects of Intellectual Property Rights (TRIPS) 2.3 Indian IPR legislations	**14**
Module 3	3.1 Nature, Origin and Scope of Patents: Essentials of Patents-Patentability Criterion Discovery and Invention 3.2 Patent Laws in Indian and International Perspective 3.3 Patent Case study: Basmati Case, Turmeric Case	**15**

Module 4	4.1 Basic Principles of Bioethics: Bioethics in Plants, Animals and Microbial Genetic Engineering; 4.2 Ethical issues in Healthcare; 4.3 Biopiracy and Bioethics 4.4 Biosafety: Definition and requirement; Laws relating to Biosafety in India: The Biological Diversity Act, 2002,	**15**

Essential readings:

1. Narayanan, P. (2010). Intellectual Property Law (3rd ed.). Eastern Law House
2. WIPO. (2017). WIPO Intellectual Property Handbook: Policy, Law and Use. World Intellectual Property Organization

Suggested readings:

3. Basheer, S., & Reddy, P. (2007). Basmati Rice Patent: Biodiversity and IPR Issues. Journal of Intellectual Property Rights, 12(1), 12-25
4. Beauchamp, T. L., & Childress, J. F. (2013). Principles of Biomedical Ethics (7th ed.). Oxford University Press.
5. Ministry of Environment, Forest and Climate Change. (2002). The Biological Diversity Act, 2002. Government of India
6. Kilner, J. F., Orr, R. D., & Shelly, J. A. (Eds.). (2002). Cutting-edge bioethics: A Christian exploration of technologies and trends. Eerdman

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	1,2
2	2.1	2
	2.2	2
	2.3	3
3	3.1	3
	3.2	2,3,6
	3.3	3,6
4	4.1	4
	4.2	4,5
	4.3	4,5
	4.4	5

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU7DSCBIF405: FUNDAMENTALS OF SYSTEMS BIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	Advanced	KU7DSCBIF405	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course provides a comprehensive introduction to Systems Biology, focusing on understanding the complexity of biological systems through both theoretical and practical approaches. Students will explore the measurement technologies, experimental methods, and simulation techniques essential for systems biology. The course covers the analysis and modeling of system behaviors, the control and robustness of biological networks, and the application of these concepts in various biological studies.

COURSE OBJECTIVES:

- To understand the principles and methodologies of systems biology

- To learn about various measurement technologies and experimental methods used in systems biology

- To explore system behavior analysis through simulation and modeling techniques

- To understand metabolic pathway regulations and database resources

- To gain knowledge about developmental systems biology and whole-cell simulations, metabolic networks of systems biology.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To Apply fundamental systems biology principles and methodologies to analyze biological systems
CO2	To Utilize advanced measurement technologies and analytical techniques for comprehensive biological data collection and interpretation
CO3	To Develop and execute simulations and models to predict and understand complex biological behaviors
CO4	To Analyze enzyme kinetics and metabolic pathways using relevant databases and software tools
CO5	To Employ systems biology software and open-source programs to control and model metabolic networks and cellular processes

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1			√	
CO 2	√			
CO 3			√	
CO 4			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Systems Biology: Towards System Understanding of Biological Systems, Measurement Technologies and experimental methods, Comprehensive Measurements, Measurement for Systems Biology, Next-generation Experimental Systems. System structure identification, Bottom-up-approach, Top-down-approach. Challenges, impacts and applications of Systems Biology, 1.2 System Behavior Analysis: Simulation, Analysis Methods, Robustness of Biological Systems, Lessons from Complex Engineering Systems. System Control; Redundancy, Modular Design, Control, Structural Stability, Impacts of systems Biology.	**14**
Module 2	2.1 Methods of study: Microarray – definition, types of array, Micro array analysis: Hierarchical clustering, Self-organizing maps. Applications of Micro Array in systems biology. 2.2 Metabolic pathway regulations: enzyme activity, enzyme kinetics, types of enzymes. Metabolic pathway databases: KEGG, EMP, BioCyc, LIGAND, BRENDA, EST, SNP, STRING Databases.	**14**

Module 3	3.1 Developmental Systems Biology: Whole cell simulation, Computer Simulation of the Cell: Human erythrocyte model & its applications, Quorum Sensing, Minimal gene set concept. genetic switches. 3.2 Principle and levels of simulation – Virtual Erythrocytes, Pathological analysis. Flux Balance Analysis;	**13**
Module 4	4.1 Controlling metabolic networking: metabolic fluxes, metabolic flux analysis, mass/flux balance analysis; and their applications towards modeling and simulation of biological systems. 4.2 Software for systems biology, graph and network in biology: BioXML, SBML, CellML; Open-source programs: eCell, Virtual Cell, BioNets; Quantitative models for E. Coli: lac operon and lambda switch. The chemotactic module in E. coli	**14**
Module 5	**Teacher Specific Module**	**5**
	Directions Expert LECTURES AND WEBINARS	

Essential readings:

1 Kitano, H. (2002). Computational systems biology. *Nature*, 420(6912), 206-210.

2 Alon, U. (2006). *An Introduction to Systems Biology: Design Principles of Biological Circuits*. Chapman & Hall/CRC

Suggested readings:

3 Kanehisa, M., Furumichi, M., Tanabe, M., Sato, Y., & Morishima, K. (2018). KEGG: new perspectives on genomes, pathways, diseases and drugs. *Nucleic Acids Research*,

4 Tomita, M., Hashimoto, K., Takahashi, K., Shimizu, T. S., Matsuzaki, Y., Miyoshi, F., ... & Saito, K. (1999). E-CELL: software environment for whole-cell simulation. *Bioinformatics*

5 Gardner, T. S., Cantor, C. R., & Collins, J. J. (2000). Construction of a genetic toggle switch in Escherichia coli. *Nature*, 403(6767), 339-342.

6 Orth, J. D., Thiele, I., & Palsson, B. O. (2010). What is flux balance analysis? *Nature Biotechnology*, 28(3), 245-248

7 Hucka, M., Finney, A., Sauro, H. M., Bolouri, H., Doyle, J. C., Kitano, H., & SBML Forum. (2003). The systems biology markup language (SBML): A medium for representation and exchange of biochemical network models. *Bioinformatics*.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1,2
	1.2	1
2	2.1	1,2
	2.2	1,3
3	3.1	3,4
	3.2	5,6,7
4	4.1	6,7
	4.2	6,7

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- System Biology analyst
- Clinical biologist

KU8DSCBIF406: BIOINSTRUMENTATION

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	Advanced	KU8DSCBIF406	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

COURSE DESCRIPTION:

This course provides an advanced biophysical method essential for molecular analysis. It covers techniques such as pH measurement, radioactive labeling and counting, various forms of electrophoresis including gel and paper electrophoresis, chromatography concepts and methods, centrifugation principles and instrumentation, microscopy techniques, X-ray crystallography, spectroscopy techniques such as Raman and NMR spectroscopy, and absorption spectroscopy fundamentals.

COURSE OBJECTIVES:

- To Understand the principles and methodologies of advanced biophysical techniques
- To Develop proficiency in conducting pH measurements, radioactive labeling, electrophoresis chromatography, centrifugation, microscopy, X-ray crystallography, and spectroscopy.
- To Analyze and interpret experimental data obtained from various biophysical methods
- To Apply biophysical techniques to solve complex molecular analysis problems.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To Demonstrate proficiency in using a wide range of biophysical techniques for molecular analysis
CO2	To Analyze and interpret experimental data using advanced biophysical methods
CO3	To Design and conduct experiments applying biophysical techniques to address specific research questions
CO4	To Communicate scientific findings effectively through written reports and presentations

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1			√	
CO 2		√		
CO 3			√	
CO 4			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 General Biophysical methods: Measurement of pH, Radioactive labeling & counting, Electrophoresis (Gel Electrophoresis, Paper Electrophoresis). 1.2 Separation & Identification of Materials - concept of Chromatography (Paper Chromatography, Partition Chromatography, Adsorption Chromatography, TLC, Ion Exchange Chromatography, Gel Chromatography, HPLC, Affinity Chromatography)	14

Module 2	2.1 Centrifugation: Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical).	**14**
	2.2 Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, Centrifugation of associating systems, sedimentation equilibrium Centrifugation.	
Module 3	3.3 Microscopy and Crystallography: Light microscopy, Bright & Dark Field microscopy, Fluorescence microscopy, TEM, SEM. X-Ray Crystallography – X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell. 3.4 Concept of different crystal structure, determination of crystal structure -concept of rotating crystal method, powder method.	**13**
Module 4	4.3 Spectroscopy: Spectroscopy: Raman Spectroscopy – Raman effect, Quantum mechanical reason of Raman effect, Basic concept of pure Rotational & Vibrational, Raman spectra of simple molecular (linear molecules). 4.4 NMR Spectroscopy- Basic principle of NMR Spectroscopy, Absorption spectroscopy- simple theory of the absorption of light by molecules, Beer-lambert law, Instrumentation for measuring the absorbance of visible light, factor affecting the absorption properties a chromophore.	**14**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

8   Wilson, K., & Walker, J. (2000). *Practical biochemistry: Principles and techniques*. Cambridge University Press.
9   Kremnery, T. (2002). *Gel chromatography*. Wiley.
10 Message, G. M. (1984). *Practical aspects of gas chromatography and mass spectrometry*. John Wiley & Sons.
11 Straughan, B. P., & Walker, S. (Year). *Spectroscopy*. Publisher.

Suggested readings:

12 Holme, R. (2019). *Analytical biochemistry*. Publisher
13 Jayaraman, J. (2010). *Lab manual in biochemistry*. Publisher
14 Miller, J. (1988). *Chromatography: Concepts and contrasts*. John Wiley & Sons, Inc.
15 Williams, B. L., & Wilson, K. (1975). *A biologist's guide to principles and techniques of practical biochemistry*. Publisher.
16 Straughan, B. B., & Walker, S. (Eds.). (2010). *Spectroscopy* (Vol. 1). Chapman and Hall Ltd
17 Nath, N., & Upadhya, P. (2020). *Biophysical chemistry*. Publisher
18 Hamilton, R. J., & Sewell, P. A. (2012). *Introduction to HPLC*. Publisher.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1,2
	1.2	1,2
2	2.1	2,7
	2.2	3,5
3	3.1	8,9
	3.2	10,11

| 4 | 4.1 | 9,10 |
| | 4.2 | 10,11 |

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU8DSCBIF407: INTRODUCTION TO R PROGRAMMING

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	Advanced	KU8DSCBIF407	4	75

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3	1	-	25	75	100	2

COURSE DESCRIPTION:

This course provides a comprehensive introduction to R programming for data analysis. It covers the history and features of R, installation and usage of R packages, basic syntax including comments, reserved words, identifiers, and constants. Additionally, the course explores variables, operators, basic data types such as numeric, integer, complex, logical, and character, as well as vectors and their operations

COURSE OBJECTIVES:

- To Understand the history, features, and basic syntax of R programming
- To Learn to work with variables, operators, and different data types in R
- To Master in the creation, manipulation, and operations of vectors and matrices in R
- To Explore advanced data structures like arrays, lists, factors, and data frames for efficient data handling in R.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Demonstrate proficiency in R programming fundamentals, including syntax and basic data types
CO2	Create and manipulate vectors, matrices, arrays, lists, factors, and data frames in R
CO3	Implement decision-making statements, loops, and functions for efficient programming in R
CO4	Connect R to external interfaces, work with packages, generate charts and graphs, read and write CSV files, and interact with databases for data analysis tasks

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1			√	
CO 2				√
CO 3			√	
CO 4			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to R History of R, Features of R, install R packages, run R packages, Comments in R, Reserved words, Identifiers, Constants, 1.2 Variables Operators: Arithmetic, Relational, Logical, Assignment, Miscellaneous, 1.3 Basic Data Types: Numeric, Integer, Complex, Logical, Character 1.4 Vectors: Creating Vectors, Combining Vectors, Accessing Vector Elements, Modifying Vectors, Deleting Vectors, Vector Arithmetic & Recycling, Vector Element Sorting, Reading Vectors.	14

Module 2	2.1 Data Structure in R Matrices: Creating Matrices, Accessing Matrix Elements, Matrix Manipulation, 2.2 Matrix Operations Arrays: Creating Arrays, Accessing Array Elements, Array Element Manipulation, 2.3 Array Arithmetic Lists: Creating Lists, Accessing List Elements, Updating List Elements, Merging Lists, List to Vector Conversion 2.4 Factors: Creating Factors, Accessing Factor Components, Merging Factors Data Frames: Creating Data Frames, Accessing Data Frame Components, Modifying Data Frames, Aggregating Data, Sorting Data, Merging Data.	**13**
Module 3	3.1 Flow Control & Functions in R Decision Making: if statement, if..else statement, Nested if..else statement, switch statement, 3.2 Loops: for Loop, while Loop, repeat Loop, Loop Control 3.3 Statements: break Statement, next Statement Built-in Functions: Mathematical Functions, Character Functions, Statistical Functions, Date and Time Functions. 3.4 Functions: Definition, Function Calling: Function without arguments, Functions with named arguments, Function with default arguments.	**13**
Module 4	4.1 Connecting R to External interfaces Packages: Installing a Package, 4.2 Loading a Package Charts and Graphs: Bar Charts, Line Graph, Pie Chart,Dot Plots 4.3 CSV Files: Reading from a CSV File, Writing to a CSV File. 4.4 Databases: Connecting R to MySQL, Creating Tables, Inserting Rows, Updating Rows, Deleting Rows, Querying Tables, Dropping Table.	**10**

	PRACTICALS	

Module 5	1. Install R and RStudio, run basic R commands
	2: Understand comments, reserved words, and constants in R
	3: Create variables and perform arithmetic operations
	4: Use relational and logical operators for comparisons.
	5: Create variables of different data types (numeric, integer, logical, character)
	6: Create, modify, and access vector elements.
	7: Perform vector arithmetic and sorting
	8: Create matrices, access elements, and perform matrix operations.
	9: Understand arrays, create arrays, and manipulate array elements also
	   convert list to vectors.
	10: Implement decision-making statements (if, if. Else, switch).
	11: Use loops (for, while, repeat) for control flow
	12: Explore break and next statements, and practice loop control, also
	   include call functions with and without arguments.
	13: Install and load external packages for data analysis
	14: Create basic charts and graphs (bar charts, line graphs, pie charts)
	15: Read data from CSV files, write data to CSV files
	16: Connect R to MySQL databases, perform basic database operations
		25

Essential readings:

1. Data Analysis and Graphics Using R: An example-based approach, Maindonald J. and Braum, J. (2007) Second Edition, Cambridge Series in Statistical and Probabilistic Mathematics
2. Statistics Using R Purohit, G.S., Gore, S.D. and Deshmikh, S.R. (2008), Narosa Publishing House
3. An R Companion to Linear Statistical Models, Hey-Jahans, C. (2012), CRC Press
4. R Programing for Data Science, Roger D. Peng (2015), Leanpub publisher

Suggested readings:

5. Sinha, P. P. (2014). *Bioinformatics with R Cookbook*. Packt Publishing
6. Vries, A. d., & Meys, J. (2015). *R For Dummies*. Wiley
7. MacLean, D. (2019). *R Bioinformatics Cookbook*. Packt Publishing.
8. Curry, E. (2020). *Introduction to Bioinformatics with R - A Practical Guide for Biologists*. CRC Press
9. Verzani, J. (2018). *Using R for Introductory Statistics*. CRC Press
10. Gentleman, R. (2018). *R Programming for Bioinformatics*. CRC Press.
11. Gardener, M. (2012). *Beginning R: The Statistical Programming Language*. Wiley.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	4
	1.4	3
2	2.1	5
	2.2	8
	2.3	9
	2.4	11
3	3.1	7
	3.2	8
	3.3	10
	3.4	11
4	4.1	9
	4.2	10
	4.3	11
	4.4	6

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T + 15P)**
Continuous Evaluation (CCA)		**35 (25T + 10P)**
THEORY		**25**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	5
d)	Viva-Voce	5
PRACTICAL		**10**
a)	Performance	4
b)	Record	4
c)	Punctuality	2
Total		**100**

Employability for the Course:

- Biotechnology/IT companies
- Database developer
- Teaching
- Programme developer/analyst
- Bioinformatics software developer

KU8DSCBIF408: MOLECULAR EVOLUTION

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	Advanced	KU8DSCBIF408	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	-	30	70	100	2

COURSE DESCRIPTION:

This course explores the principles and mechanisms of molecular evolution, focusing on the comparison of DNA sequences, evolutionary models, and the molecular clock hypothesis. Students will learn about the processes of convergent and divergent evolution, mutation versus substitution, and the rates of molecular evolution. The course includes advanced topics such as genome evolution, RNA structure and evolution, compensatory substitutions, and the fitting of evolutionary models to sequence data.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To able to compare DNA sequences to calculate gene distances, understand the concepts of convergent and divergent evolution, and distinguish between mutation and substitution rates in molecular evolution
CO2	To apply models like the Jukes Cantor correction to estimate evolutionary distances and fit evolutionary models to sequence data. They will understand the role of compensatory substitutions and the comparative method in evolutionary studies
CO3	To gain insights into genome evolution, the structure and evolution of RNA, and how thermodynamics influences RNA sequence evolution. They will also be familiar with the molecular mechanisms of the molecular clock and its significance
CO4	To explore the neutral theory, gene family organization, and the applications of molecular phylogenetics in various biological contexts, including recently diverged species and databases of molecular evolution.
CO5	To learn to distinguish between paralogy and orthology, understand coordinated gene expression in evolution, and analyze genome content, structure, and the evolution of recently diverged species using molecular evolution databases

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2			√	
CO 3				√
CO 4			√	
CO 5	√			

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Comparison of DNA sequences to calculate gene distance; 1.2 Convergent and divergent evolution; Mutation Vs. Substitution-Rate of Molecular Evolution. 1.3 Jukes Cantor Correction and evolutionary distance	**15**
Module 2	2.1 Genome evolution, RNA structure and evolution, 2.2 Compensatory substitutions and the comparative method, Fitting evolutionary models to sequence data, 2.3 The influence of thermodynamics on RNA sequence evolution	**15**
Module 3	3.1 Molecular clock- Concepts and significance-molecular mechanisms of molecular clock. 3.2 Neutral theory -gene family organization. Applications of molecular phylogenetics	**13**
Module 4	4.1 Paralogy and Orthology- coordination expression in evolution-genome: content, structure and evolution. 4.2 Molecular evolution of recently diverged species - Databases of Molecular evolution.	**12**
Module 5	Teacher Specific Module	**5**
	Directions	

Essential readings:
1. Graur, D., & Li, W.-H. (2000). **Fundamentals of Molecular Evolution** (2nd ed.). Sinauer Associates.
2. Nei, M., & Kumar, S. (2000). **Molecular Evolution and Phylogenetics**. Oxford University

Suggested readings:

3. Page, R. D. M., & Holmes, E. C. (1998). **Molecular Evolution: A Phylogenetic Approach**. Blackwell Science.
4. Felsenstein, J. (2004). **Inferring Phylogenies**. Sinauer Associates
5. Kimura, M. (1983). **The Neutral Theory of Molecular Evolution**. Cambridge University Press

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	1,2
2	2.1	2
	2.2	2,3
	2.3	3
3	3.1	3
	3.2	4
4	4.1	4,5
	4.2	5

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper	10
b)	Assignment	5
c)	Seminar	10
d)	Viva	5
Total		**100**

Employability for the Course:

- Biotechnology/IT companies
- Database developer
- Teaching
- Programme developer/analyst
- Bioinformatics software developer

KU1MDCBIF101: FUNDAMENTALS OF BIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	MDC	Foundation	KU1MDCBIF101	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3	0	0	25	50	75	1hr 30 min

COURSE DESCRIPTION:

This course provides a comprehensive overview of fundamental concepts in biology, covering topics such as biological classification, plant and animal organization, physiology, genetics, evolution, common diseases, biotechnology, and bioinformatics. Students will explore the diversity of life forms, cellular structures, metabolic processes, and the applications of biotechnology and bioinformatics in various fields

COURSE OBJECTIVES:

- To introduce students to the branches of biology, basic principles, and biological classification systems
- To explore the organization of plants and animals, including their form, structure, function, and classification
- To investigate cellular biology, biomolecules, metabolism, and physiological processes in plants, animals, and humans
- To discuss the principles of genetics, evolution, common diseases, biotechnology tools, and bioinformatics applications

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To Develop a foundational understanding of key concepts in biology, including classification, diversity, and taxonomic categories
CO2	To Recognize and differentiate between plant and animal cellular structures, functions, and metabolic processes
CO3	To Understand the physiological mechanisms governing plant growth, development, photosynthesis, respiration, and transportation
CO4	To Analyze the principles of genetics, evolution, human physiology, common diseases, biotechnology tools, and their real-world applications.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3		√		
CO 4			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Biology, Branches of Biology, Basic Principles of Biology 1.2 Biological Classification-Two kingdom and Five kingdom classification, Viruses, Viroid's and Lichens 1.3 Diversity in the living world, Taxonomic categories, Taxonomic aids 1.4 Plant organization-The form, structure and function of plant vegetative and reproductive organs, Classification of Plant Kingdom,	**10**
Module 2	2.1 Basis of Animal Classification, Classification of Animal Kingdom 2.2 Biomolecules and metabolism: Ultra structure of cell and Cell organelles (Structure and Functions), Plant cell vs Animal cell 2.3 Plant Physiology: Photosynthesis, Respiration, Transportation, Mechanisms of Nitrogen fixation 2.4 Plant growth and development, physiology of flowering	**10**
Module 3	3.1 Human Physiology: Digestion, Respiration, Circulation 3.2 Male and female reproductive organs, gametogenesis, fertilization 3.3 Principles of Biology: Genetics: Mendel's laws of inheritance, Genetic disorders- Colour blindness, Sickle cell anemia 3.4 Evolution: Geological time scale for evolution of plants and vertebrates, Origin and evolution of plants and man	**10**
Module 4	4.1 Common Human Diseases: causing organism, prevention and treatment- corona, malaria, dengue, AIDS, cancer 4.2 Common Plant Diseases: causing organism, prevention and treatment- Leaf spots, Black spot. 4.3 Biotechnology: Tools and process of recombinant DNA technology, Applications of biotechnology in agriculture, food industry, medicine and transgenic animals. 4.4 Bioinformatics: tools and applications in various fields.	**10**
Module 5	**Teacher Specific Module** *Directions*	**5**

Essential readings:

1. Sreekrishna V. (2005). Biotechnology –I, Cell Biology and Genetics. New Age International Publ. New Delhi, India.
2. Rastogi, S.C., 2019). Essentials of animal physiology. 4th Edition. New Age International Publishers

Suggested readings:

3. Pandey, B.P. (2013) College Botany, Volume-I, S. Chand Publishing, New Delhi.
4. Kotpal, R.L.(2022). Modern textbook of zoology, Vertebrates. (Rastogi Publ., Meerut).
5. Verma P.S., Agarwal V.K., (2006). Cell biology, genetics, Molecular Biology, Evolution and Ecology. S. Chand publishers, New Delhi, India

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	1
	1.3	2
	1.4	2
2	2.1	2
	2.2	3
	2.3	2
	2.4	4
3	3.1	3
	3.2	4
	3.3	4
	3.4	3
4	4.1	4
	4.2	4
	4.3	5
	4.4	5

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper	10
b)	Assignment	10
c)	Seminar/viva	5
Total		**75**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU2MDCBIF102: FUNDAMENTALS OF CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	MDC	Foundation	KU2MDCBIF102	3	45
Learning Approach (Hours/ Week)			Marks Distribution		

Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	Duration of ESE (Hours)
3	0	0	25	50	75	1hr 30 min

COURSE DESCRIPTION:

This course covers the foundational concepts of chemistry, including the nature of matter, atomic structure, chemical bonding, acids, bases, salts, and their significance in daily life applications such as food, drugs, textiles, preservatives, soaps, and detergents. Students will learn about classification of matter, atomic theories, electronic configurations, bonding principles, and chemical properties relevant to various industrial and household contexts.

COURSE OBJECTIVES:

- To Introduce students to the basic concepts of matter, atoms, molecules, and nuclear chemistry
- To Explore the classification of elements, periodic properties, chemical bonding types, and properties of ionic and covalent compounds
- To Discuss the definitions, types, properties, and strength of acids, bases, and salts.
- To Highlight the importance of chemistry in daily life applications such as food, drugs, textiles, preservatives, soaps, and detergents.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Develop a solid understanding of atomic theories, atomic models, and quantum numbers governing atomic structure
CO2	Analyze the periodic classification of elements based on electronic configuration and their periodic properties
CO3	Apply knowledge of chemical bonding principles to predict properties of ionic and covalent compounds
CO4	Recognize the significance of chemistry in various aspects of daily life including food preservation, pharmaceuticals, textile production, and hygiene products.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3		√		
CO 4			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1. Matter, Atoms, Molecules & Nuclear Chemistry: Classification of matter, Dalton atomic theory, Thomson Model, Rutherford Model, Bohr's model of atom, quantum numbers, electronic configuration, 1.2. Aufbau Principle, Pauli's exclusion principle, Hund's rule. Isotopes- Isobars, Nuclear decay, Band of Stability, Nuclear Reaction types, Nuclear Applications.	**10**
Module 2	2.1 Elements, Classification and Chemical Bonding: Classification of elements, Periodic Classification of elements based on electronic configuration, classification into types, classification into metals, non-metals and metalloids, 2.2 periodic properties atomic radii, ionisation enthalpy, electronegativity, Octet rule, ionic bond properties of Ionic compounds-covalent bond, properties of covalent molecule.	**10**
Module 3	3.1 Acids, Bases, Salts, Chemistry in Daily life: Definition, types and properties of Acids, Bases, Salts, strength of acids and bases, pH. 3.2 3.2 Importance of Chemistry in daily life. (Food, drugs, textiles, preservatives, soaps and detergents.)	**11**
Module 4	4.1 Importance of Chemistry in food, drugs 4.2 Importance of Chemistry in textiles, preservatives, soaps and detergents.	**9**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

1. Puri, R. K., & Sharma, J. K. (2010). *Inorganic Chemistry*. CRC Publisher
2. Singh, D. N. (2010). *Basic concepts of inorganic chemistry*. CRC Publisher
3. Chang, R. (2010). Chemistry (11th ed.). McGraw-Hill Education

Suggested readings:

4. Tro, N. J. (2016). *Chemistry: A Molecular Approach* (4th ed.). Pearson

5. Brown, T. L., LeMay, H. E., Bursten, B. E., Murphy, C., & Woodward, P. (2017). *Chemistry: The Central Science* (14th ed.). Pearson

6. Kotz, J. C., Treichel, P., Townsend, J., & Treichel, D. (2019). *Chemistry & Chemical Reactivity* (10th ed.). Cengage Learning.

Reference Distribution:

Module	Reference No.
1	1
	2
	2
	2
2	2
	2
	3
	3
3	4
	5
	4
	5
4	5
	5
	6

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper	10
b)	Assignment	10
c)	Seminar/viva	5
Total		**75**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU3MDCBIF201: INTRODUCTION TO CELL BIOLOGY AND MICROBIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	MDC	Intermediate	KU3MDCBIF201	3	45

Learning Approach (Hours/ Week)			Marks Distribution			
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	Duration of ESE (Hours)
3	0	0	25	50	75	1hr 30 min

COURSE DESCRIPTION:

This course provides the basic understanding of cell biology, microbiology, and sterilization techniques essential in biotechnology, microbiology. Students will learn about cell organization in prokaryotic and eukaryotic cells, focusing on organelles such as mitochondria, chloroplasts, lysosomes, Golgi bodies, the plasma membrane, cytoskeleton, cell wall, and the nucleus. Additionally, the course covers cell division processes (mitosis and meiosis), chromosome structure, gene concepts, microbial classification, pure culture techniques, sterilization methods, microbial growth principles, and contamination control.

COURSE OBJECTIVES:

- To Understand the cellular structure and functions of organelles in both prokaryotic and eukaryotic cells
- To Differentiate between plant and animal cells based on structural and functional characteristics
- To Explore cell division processes, chromosome structure, gene concepts, and DNA packaging
- To Learn about microbial classification, pure culture techniques, sterilization methods, and microbial growth principles.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Gain proficiency in identifying and explaining the roles of organelles in cell function and organization
CO2	Compare and contrast the structural differences between plant and animal cells
CO3	Demonstrate knowledge of cell division processes, chromosome structure, and gene concepts
CO4	Apply principles of microbiology, pure culture techniques, sterilization methods, and microbial growth control in laboratory settings.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4				√

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Cell as a basic unit of life., Cell organization of prokaryotic and eukaryotic cells, 1.2 Structural and functional capitalization of cell: Mitochondria, Chloroplast, Lysosomes, Golgi bodies, Plasma membrane, Cytoskeleton, Cell wall and Nucleus. 1.3 Differentiate plant and animal cell.	**10**
Module 2	2.1 Cell cycle, cell division - mitosis and meiosis. 2.2 Chromosome structure, gene, gene number, gene clusters and Pseudogene, Polytene and lamp brush chromosomes, 2.3 Packing of DNA, supercoiled DNA nucleosome, satellite DNA, Cell trafficking.	**10**
Module 3	3.1 Structure, classification and general characteristics of Bacteria, (including ribotyping), Mycoplasma, Protozoa, Archaea and yeast, Fungi. Association of bacteria, 3.2 Methods in microbiology: Pure culture techniques, principles of microbial nutrition, construction of culture media, enrichment culture, techniques for isolation of chemoautotrophs, chemoheterotrophs.	**09**
Module 4	4.1 Sterilization-Application of sterilization methods in biotechnology, Various sterilization methods, Microbial contamination control and Sterility testing. 4.2 Microbial growth: The definition of growth, mathematical, expression of growth, growth curve, measurement of growth and growth yield, synchronous growth.	**11**
Module 5	**Teacher Specific Module** *Directions*	**5**

Essential readings:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). *Molecular Biology of the Cell* (4th ed.). Garland Science

Suggested Readings:

2. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (2000). *Molecular Cell Biology* (4th ed.). W. H. Freeman

3. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). *Molecular Biology of the Cell* (4th ed.). Garland Science

4. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock Biology of Microorganisms* (15th ed.). Pearson *Microbiology: An Introduction*

5. Tortora, G. J., Funke, B. R., & Case, C. L. (2017). ed.). Pearson.

Reference Distribution:

Module	Reference No.
1	1
	1
	2
	2
2	2
	2
	3
	3
3	4
	5
	4
	5
4	5
	5
	5

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper	10
b)	Assignment	10
c)	Seminar/viva	5
Total		**75**

Employability for the Course:

- Biotechnology companies
- Research and Development Assistant
- Teaching
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU4SECBIF201: INTRODUCTORY STATISTICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	SEC	Intermediate	KU4SECBIF201	3	45

Learning Approach (Hours/ Week)			Marks Distribution			
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	Duration of ESE (Hours)
3	0	0	25	50	75	1hr 30 min

COURSE DESCRIPTION:

This course provides a foundational understanding of biostatistics, focusing on variables, attributes, population vs. sample, criteria vs. predictors, and parametric vs. non-parametric statistics. Students will learn about sample and probability distributions, graphical and tabular data presentation, measures of central tendency and dispersion, hypothesis testing, correlation, regression, and probability theory as applied in biological sciences.

COURSE OBJECTIVES:

- Define variables and attributes and understand their significance in biostatistics, Differentiate between population and sample, criteria and predictors.
- Explore sample and probability distributions, random vs. biased sampling methods, and their implications in statistical analysis.
- Learn graphical and tabular presentation techniques including line diagrams, bar diagrams, pie charts, histograms, scatter plots, and box-whisker plots.
- Understand hypothesis testing concepts including null and alternative hypotheses, levels of significance, critical scores, and types of errors and apply parametric tests such as Z-test, Student's t-test, and nonparametric tests like Chi-square and G-test for goodness of fit.
- Explore probability theory concepts including random experiments, sample space, events, and independence of events.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Demonstrate proficiency in defining variables, attributes, and understanding their roles in biostatistics.
CO2	Apply statistical techniques to differentiate between population and sample, and parametric vs. non-parametric statistics.
CO3	Utilize graphical and tabular methods for data presentation and interpretation in biological sciences.

CO4	Calculate and interpret measures of central tendency and dispersion, facilitating data analysis and decision-making.
CO5	Perform hypothesis testing, correlation, regression, and probability calculations relevant to biological research.

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2			√	
CO 3		√		
CO 4			√	
CO 5				√

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Biostatistics: Variables and attributes 1.2 Population vs. sample; Criterion vs. predictor; Statistics and Parameters; Parametric vs. Non-parametric statistics 1.3 Sample distribution and Probability distribution; Random vs. Biased sampling	10
Module 2	2.1 Graphical and Tabular presentation of data: Line diagram; Bar diagram; Pie chart; Histogram; 2.2 Scatter plots; Box-whisker plots; Frequency distribution charts; Frequency Polygon & Ogive; Skewness & Kurtosis.	10
Module 3	3.1 Measures of central tendency: Arithmetic Mean; Median; Mode of raw data and grouped data. 3.2 Measures of dispersion: Variance; Standard deviation; Standard error of mean; Standard score.	09
Module 4	4.1 Testing of Hypothesis: Null hypothesis and alternative hypothesis; levels of significance; critical scores; errors of interference, Z test, Student's t-test. 4.2 Nonparametric statistics: Chi-square test, G test for goodness of fit. 4.3 Correlation: Tests for parametric and nonparametric variables. Regression: Linear regression. 4.4 Probability - Random Experiments, sample space, event, elementary event, compound event, impossible events, certain events, equally likely events, mutually exclusive events, and exhaustive events, dependent and independent events,	11
Module 5	**Teacher Specific Module**	5
	Directions	

Essential readings:

1. Gupta, S. C., & Kapoor, V. K. (2019). *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons

2. Pagano, M., & Gauvreau, K. (2018). *Principles of Biostatistics*. Cengage Learning

3. Daniel, W. W., & Cross, C. L. (2019). Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley.

4. Rosner, B. (2015). Fundamentals of Biostatistics. Cengage Learning.

Suggested readings:

5. Bhat. B. R, Srivenkatramana T. & Madhav Rao K. S. (1996) Statistics. A Beginners Text. Vol . I New Age International (p) Ltd.

6. Ithal, U. B., & Naik, B. U. (2010). *Statistical methods I*. Phadake Prakashan, Kolhapur.

7. Gupta, S. C., & Kapoor, V. K. (2019). *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons.

8. Arora, P. N., & Malhan, P. K. (2008). *Biostatistics*. Himalaya Publishing House

9. Pillai, R. S. N., & Bagavathi, V. (2016). *Statistics*. S. Chand and Co Ltd.

10. Daniel, W. W., & Cross, C. L. (2019). Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley.

11. Daniel, W. W. (2010). Biostatistics: Basic Concepts and Methodology for the Health Sciences. Wiley.

12. Rosner, B. (2015). Fundamentals of Biostatistics. Cengage Learning.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	2
	1.3	3,4
2	2.1	4
	2.2	5,6
3	3.1	10,7
	3.2	12
4	4.1	6,7
	4.2	12
	4.3	11
	4.4	9

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper	10
b)	Assignment	10

c)	Seminar/viva	5
	Total	**75**

Employability for the Course:
- Biotechnology/IT companies
- Database developer
- Teaching
- Programme developer/analyst
- Bioinformatics software developer

KU5SECBIF301: BIOMOLECULES AND METABOLISM

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	SEC	Higher	KU5SECBIF301	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3	0	0	25	50	75	1hr 30 min

COURSE DESCRIPTION:

This course will provide the fundamental biomolecules essential for life processes, focusing on carbohydrates, proteins, lipids, enzymes, and nucleic acids. Students will explore the classification, structures, metabolism, and regulation of these biomolecules, gaining insight into their roles in cellular pathways and overall metabolic processes.

COURSE OBJECTIVES:

- To Understand the classification, structures, and metabolism of biomolecules such as carbohydrates, proteins, lipids, enzymes, and nucleic acids.
- To Analyze the regulation of key metabolic pathways including glycolysis, the Krebs cycle, and the urea cycle.
- To Explore the structure-function relationships of proteins and enzymes, including their classification, folding dynamics, and catalytic mechanisms.
- To Investigate the synthesis and functions of lipids, including fatty acids, triglycerides, phospholipids, and steroids.
- To Examine the role of enzymes and nucleic acids in cellular processes, including enzyme kinetics, nucleotide metabolism, and genetic information transfer.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	To classify and describe the structures of biomolecules, including carbohydrates, proteins, lipids, enzymes, and nucleic acids.
CO2	To demonstrate an understanding of metabolic pathways such as glycolysis, the Krebs cycle, and the urea cycle, including their regulation and significance in cellular energy production.
CO3	To analyze protein structure-function relationships, including the classification of proteins based on size, shape, and biological function, and the dynamics of protein folding and unfolding.
CO4	To evaluate the synthesis, properties, and functions of lipids, including fatty acids, triglycerides, phospholipids, and steroids, and their roles in cellular membranes and signaling and interpret biochemical pathways

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2			√	
CO 3		√		
CO 4			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Classification, Structures and Carbohydrate Metabolism, Classification, characteristics and functions of monosaccharides, disaccharides – polysaccharides 1.2 Epimers, isomers, anomers, chiral carbon atom, glucopyranose and fructopyranose, 1.3 General scheme of metabolism, historical and experimental details in derivation of a metabolic pathway, Glycolysis - aerobic and anaerobic, 1.4 Regulation of glycolysis, Krebs cycle and its regulation.	**10**

Module 2	2.1 Amino Acids and Proteins Chemical structure and general properties of amino acids, pH of amino acids, acid base concepts, Henderson and Hasselbalch equation. 2.2 General metabolism scheme of amino acids and Urea cycle Proteins Classification- size, shape, degree of association, complexity. Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural, defense and regulatory). 2.3 Protein structure, Secondary structure - alpha helix and beta pleated structure, and Super secondary structures, Tertiary structure - forces stabilizing tertiary structure, unfolding/refolding experiment, prediction of secondary and tertiary structure. 2.4 Dynamics of protein folding, role of molecular chaperones in protein folding, Lysosomal and membrane proteins. Quaternary structure - forces stabilizing quaternary structure, Structure function relationship - myoglobin and hemoglobin.	**10**
Module 3	3.1 Lipids Definition and classification of lipids. 3.2 Fatty acids – general formula, nomenclature and chemical properties Structure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids, steroids and prostaglandins. 3.3 Synthesis of fatty acid - structure and composition of fatty acid synthetase complex, pathway and regulation. 3.4 synthesis of triacyl glycerides, Ketone bodies – formation.	**10**
Module 4	4.1 Enzymes and Nucleic acids, Classification of enzymes, IUB system, enzyme substrate complex, active site of enzymes 4.2 stereo specificity and ES complex formation, Effect of temperature and pH and substrate concentration on reaction rate, Activation energy, transition state theory, enzyme activity. 4.3 Michaelis Menten equation, significance of Vmax and Km, Enzyme inhibition, types of inhibitors and mode of action 4.4 Chemical modification of enzymes, Structure and functions of Ribonuclease, trypsin, chymotrypsin.	**10**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

1. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2019). Biochemistry. W. H. Freeman
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell. Garland Science

Suggested readings:

3. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Principles of Biochemistry. Wiley.
4. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2013). Essential Cell Biology. Garland Science.
5. Garrett, R. H., & Grisham, C. M. (2016). Biochemistry. Cengage Learning.
6. Nelson, D. L., & Cox, M. M. (2017). Lehninger Principles of Biochemistry. W. H. Freeman.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	2,1
	1.2	1
	1.3	3
	1.4	2,3
2	2.1	3
	2.2	2
	2.3	3
	2.4	1
3	3.1	4
	3.2	6
	3.3	4
	3.4	1
4	4.1	5
	4.2	5
	4.3	4
	4.4	6

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper	10
b)	Assignment	10
c)	Seminar/viva	5
Total		**75**

Employability for the Course:
- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU6SECBIF302: PERL PROGRAMMING

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	SEC	Higher	KU6SECBIF302	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
2	1	0	15(T) 10(P)	35(T) 15(P)	50 25	1hr 30 min

COURSE DESCRIPTION:

This comprehensive course is designed to equip you with a deep understanding of Perl programming, from basic elements to advanced data structures and control flow. Whether you're a beginner or looking to enhance your Perl skills, this course covers everything that a student need to know to become proficient in Perl scripting.

COURSE OBJECTIVES:

- Develop a strong foundation in Perl programming fundamentals
- Learn to write efficient and readable Perl scripts for various applications
- Gain proficiency in using Perl's built-in functions and control structures
- Understand Perl documentation and resources for self-learning and troubleshooting
- Apply Perl programming concepts to real-world projects and scenarios.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to-

C01	Introduction to Perl, Basic Elements of Perl Scripting, Command-line Options used with perl, Perl Documentation and Help.
C02	Scalars, Assignment of Scalar Data to Scalar Variables, Scalar Operators, Strings
C03	Listing Control Structures: if Statements, Loops, Loop Control Statements
C04	Implementing Hashes: Hashes, Hash Functions, Iterations on Hashes, Operations on Hash Element

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2			√	
CO 3		√		
CO 4			√	

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	Describing the PERL programming language 1.1 Introduction to PERL Programming 1.2 Basic elements of perl scripting 1.3 Command line option used with perl 1.4 Perl documentation and help	**10**
Module 2	2.1 Implementing scalars: scalars 2.2 Assignment of scalar data to scalar variables 2.3 Scalars operators 2.4 Strings	**10**
Module 3	3.1 Listing control structures: of statements 3.2 Loops 3.3 loop control statements	**09**
Module 4	4.1 Implementing arrays and hashes: arrays 4.2 Array functions: back quotes and command execution 4.3 scalar and list context, Hash and Hash functions 4.4 Iteration on hashes, operations, Hash elements	**11**
Module 5	**Teacher Specific Module**	**5**
	Directions	

Essential readings:

1. Schwartz, R. L., Phoenix, T., & foy, b. d. (2016). *Learning Perl*. O'Reilly Media
2. Schwartz, R. L., foy, b. d., & Phoenix, T. (2006). *Intermediate Perl*. O'Reilly Media.
3. chromatic. (2015). *Modern Perl*. Onyx Neon Press.
4. Wall, L., Christiansen, T., & Orwant, J. (2012). *Programming Perl*. O'Reilly Media.

Suggested readings:

5. Wall, L., Christiansen, T., & Orwant, J. (2012). *Programming Perl*. O'Reilly Media.

Reference Distribution:

Module	Unit	Reference No.
1	1.1	2,1
	1.2	1
	1.3	3
	1.4	2,3
2	2.1	3
	2.2	2
	2.3	3
	2.4	1
3	3.1	4
	3.2	6
	3.3	4
	4.1	5

	4.2	5
4	4.3	4
	4.4	5

Assessment Rubrics

Evaluation Type		Marks(Theory)	Marks(practical)
End Semester Evaluation		35	15
Continuous Evaluation		15	10
a)	Test Paper/performance	5	5
b)	Assignment	5	-
c)	Seminar/viva/result	5	5
Total		**50**	**25**

Employability for the Course:

- Bioinformatics Analyst
- Research and Development Assistant
- Teaching
- Clinical Biology Coordinator
- Biological Technicians
- Database Analyst
- Technical/ Project Assistant
- Research Assistant

KU3VACBIF201: INTRODUCTION TO HTML

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	VAC	Intermediate	KU3VACBIF201	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
2	1	0	15(T) 10(P)	35(T) 15(P)	50 25	1hr 30 min

COURSE DESCRIPTION:

This course provides a comprehensive introduction to HTML (Hypertext Markup Language) for individuals interested in web development. Students will learn the basics of creating web pages, including structuring content, working with links and images, designing forms, and utilizing tables. The course covers essential HTML elements, attributes, and best practices for writing clean and valid code.

COURSE OBJECTIVES:

- To Understand the foundational concepts of web development and the role of HTML in creating web pages
- To Learn how to structure HTML documents using tags and elements for organizing content effectively
- To Gain proficiency in creating hyperlinks, inserting images, and designing basic forms to enhance interactivity
- To Develop skills in using HTML tables for data presentation and grasp advanced topics such as semantic elements and multimedia embedding.

Course Prerequisite: NIL
COURSE OUTCOMES:
Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Create well-structured HTML documents with appropriate tags and elements
CO2	Design and implement hyperlinks, images, lists, forms, and tables within HTML documents
CO3	Apply HTML best practices to ensure code readability, accessibility, and compliance with web standards
CO4	Demonstrate an understanding of advanced HTML topics, including semantic elements, multimedia embedding, and meta tags.

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to web development and html, Setting up a text editor, Basic structure of an HTML document, 1.2 HTML tags and elements, creating headings, paragraphs, and line breaks.	10
Module 2	2.1 Creating hyperlinks (internal, external, and anchors), Linking to email addresses and phone numbers, Inserting images using **<img>** tag 2.2 Image attributes (alt, src, width, height), Creating ordered and unordered lists, Nesting lists and list items.	10
Module 3	3.1 Creating HTML forms (text inputs, checkboxes, radio buttons, dropdowns), Form attributes (action, method), Creating a basic contact form, 3.2 introduction to tables in HTML, Table structure (table, tr, th, td), Spanning rows and columns in tables.	10
Module 4	4.1 Working with iframes for embedding content, HTML entities and special characters, Meta tags for SEO and viewport settings 4.2 semantic HTML elements (header, footer, nav, article, section), Introduction to HTML5 audio and video elements. Develop a webpage design with html.	10
	Teacher Specific Module	**5**

Module 5	*Directions*	

Essential readings:

1. Duckett, J. (2011). HTML and CSS: Design and Build Websites. Wiley

Suggested readings:

2. freeman, E., & Robson, E. (2014). Head First HTML and CSS: A Learner's Guide to Creating Standards-Based Web Pages. O'Reilly Media
3. W3C HTML Specification. (n.d.). Retrieved from https://www.w3.org/TR/html/
4. MDN Web Docs. (n.d.). HTML: HyperText Markup Language. Retrieved from https://developer.mozilla.org/en-US/docs/Web/HTML

Reference Distribution:

Module	Unit	Reference No.
1	1.1	1
	1.2	1
	1.3	2
	1.4	2
2	2.1	2
	2.2	1
	2.3	1
	2.4	2
3	3.1	3
	3.2	2
	3.3	1
	3.4	2
4	4.1	4
	4.2	4
	4.3	4
	4.4	4

Assessment Rubrics

Evaluation Type		Marks(Theory)	Marks(practical)
End Semester Evaluation		**35**	**15**
Continuous Evaluation		**15**	**10**
a)	Test Paper/performance	5	5
b)	Assignment	5	-
c)	Seminar/viva/result	5	5
Total		**50**	**25**

Employability for the Course:

- Biotechnology/IT companies
- Database developer
- Teaching
- Programme developer/analyst

- Bioinformatics software developer

KU4VACBIF202: BIOLOGICAL DATABASES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	Intermediate	KU4VACBIF202	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
2	1	0	15(T) 10(P)	35(T) 15(P)	50 25	1hr 30 min

COURSE DESCRIPTION:

This course gives an advanced bioinformatics resources and tools essential for genomics, proteomics, and structural biology analyses. Students will learn to navigate databases such as NCBI, RCSB, ExPASy, and utilize search engines like Entrez. Additionally, the course covers open-access bibliographic resources, genomics databases, sequence databases, structure databases, derived databases, sequence file formats, and prediction tools for protein and nucleic acid properties. Practical sessions will include hands-on training in using visualization tools for molecular structure analysis.

COURSE OBJECTIVES:

- To Familiarize students with prominent bioinformatics resources like NCBI, RCSB, and ExPASy
- To Introduce database search engines and bibliographic resources such as Entrez, PubMed, and PUBMED Central
- To Provide an overview of genomics databases, sequence databases, and their repositories.
- To Explore structure databases, derived databases, sequence file formats, and tools for protein/nucleic acid analysis.

Course Prerequisite: NIL

COURSE OUTCOMES:

Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Proficiency in utilizing bioinformatics resources for data retrieval and analysis from NCBI, RCSB, and ExPASy
CO2	Competence in using database search engines like Entrez and accessing open-access bibliographic resources
CO3	Ability to navigate and retrieve data from genomics databases and repositories
CO4	Skill in handling sequence file formats and using tools for protein/nucleic acid property analysis

CO5	Capability to visualize protein/DNA structures using molecular visualization tools

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4			√	
CO 5				√

COURSE CONTENTS:

Module	Description	Teaching Hours
Module 1	1. Bioinformatics Resources: NCBI, RCSB, ExPASy 2. Database search engines: Entrez 3. Open access bibliographic resources and literature databases a. PubMed b. PUBMED Central c. Public Library of Sciences (PloS)	**20**
	4. Genomics database at ExPASy 5. Sequence databases: a. Nucleic acid sequence databases: GenBank, EMBL, DDBJ; b. Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL c. Repositories for high throughput genomic sequences: EST, STS, GSS. d. Genome Databases at NCBI, EBI, TIGR, SANGER 6. Structure Databases: PDB, NDB, PubChem, ChemBank, FSSP, DSSP 7. Derived Databases: InterPro, Prosite, Pfam, ProDom 8. Sequence file formats: GenBank, FASTA, PIR,CLUSTAL, SWISSPROT 9. Protein and nucleic acid properties: Proteomics tools at the ExPASy server, EMBOSS 10. Secondary Structure Prediction tools 11. Tertiary Structure Prediction tools 12. Visualise the protein/DNA molecule using any visualization tool.	**20**
Module 2	**Teacher Specific Module**	**5**

	Directions	

Core Compulsory reading:

1. Altschul, S. F., Gish, W., Miller, W., Myers, E. W., & Lipman, D. J. (1990). Basic local alignment search tool. *Journal of Molecular Biology*
2. Thompson, J. D., Higgins, D. G., & Gibson, T. J. (1994). CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Research*

Core suggested and additional reading:

3. Jones, D. T. (1999). Protein secondary structure prediction based on position-specific scoring matrices. *Journal of Molecular Biology*
4. Altschul, S. F., Gish, W., Miller, W., Myers, E. W., & Lipman, D. J. (1990). Basic local alignment search tool. *Journal of Molecular Biology*
5. Bailey, T. L., & Elkan, C. (1994). Fitting a mixture model by expectation maximization to discover motifs in biopolymers. *Proceedings of the Second International Conference on Intelligent Systems for Molecular Biology*
6. Attwood, T. K., & Gisel, A. (2002). Discovering and displaying sequence patterns with block maker and block viewer. *Bioinformatics.*
7. Krogh, A., Larsson, B., von Heijne, G., & Sonnhammer, E. L. (2001). Predicting transmembrane protein topology with a hidden Markov model: application to complete genomes.

Reference Distribution:

Module	Unit	Reference No.
1	1,2,3,4	1,2
	5,6,7,8	1,3,4
	9,10	5,6,7
	11,12	6,7

Assessment Rubrics

Evaluation Type		Marks(Theory)	Marks(practical)
End Semester Evaluation		**35**	**15**
Continuous Evaluation		**15**	**10**
a)	Test Paper/performance	5	5
b)	Assignment	5	-
c)	Seminar/viva/result	5	5
Total		**50**	**25**

- **Employability for the Course:**

- Biotechnology/IT companies
- Database developer
- Teaching
- Programme developer/analyst

- Bioinformatics software developer

KU4VACBIF203: COMPUTATIONAL METHODS IN BIOINFORMATICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	Intermediate	KU4VACBIF203	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
2	1	0	15(T) 10(P)	35(T) 15(P)	50 25	1hr 30 min

COURSE DESCRIPTION:

This course provides a comprehensive overview of computational tools and methods used in bioinformatics for sequence analysis, alignment, structure prediction, motif analysis, and phylogenetic analysis. Students will learn to utilize various software tools and databases and more for analyzing biological sequences and structures. Practical sessions and case studies will enhance hands-on experience in bioinformatics analysis.

COURSE OBJECTIVES:

- To Understand the principles and applications of sequence databases and search tools
- To Perform pair-wise alignments using dot plots and global/local alignment methods
- To Conduct multiple sequence alignments using Clustal and Dialign
- To Apply primary and secondary structure prediction methods such as GOR, PSI-pred, and Chou-Fasman.
- To Explore techniques for binding site identification and sequence pattern analysis.

Course Prerequisite: NIL
COURSE OUTCOMES:
Course Learning Outcomes: At the end of the Course, the Student will be able to -

CO1	Ability to navigate and utilize sequence databases like EMBOSS and Expasy tools efficiently
CO2	Proficiency in conducting sequence similarity searches using BLAST and FASTA
CO3	Competence in pair-wise sequence alignment techniques including dot plots and global/local alignments
CO4	Skill in multiple sequence alignment using Clustal and Dialign for comparative genomics studies
CO5	Capability to predict protein structures, binding sites, and analyze sequence motifs and profiles using various bioinformatics tools

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4			√	
CO 5				√

COURSE CONTENTS:

Module	Description	Teaching Hours

Module 1	1. Sequence Databases: EMBOSS, Expasy tools
	2. Search tools against Databases:
	  a. BLAST (types)
	  b. FASTA
	3. Pair wise alignment:
	  a. Dot Plot
	  b. Global and Local alignment methods
	4. Multiple sequence alignment:
	  a. Clustal
	  b. Dialign
	5. Primary and secondary structure prediction methods
	  a. GOR Method
	  b. PSI-pred
	  c. Chou-Fasman method
	6. Binding site identification
	7. Sequence patterns and profiles:
	  a. generation of sequence profiles
	    i. PSI-BLAST
	  b. derivation of and searching sequence patterns:
	    i. MEME/MAST
	    ii. PHI-BLAST
	    iii. SCanProsite
	    iv. PRATT
	8. Protein motif and domain analysis:
	  a. eMotif
	  b. InterproScan
	  c. ProSite
	9. Phylogentic analysis – Mega, Paup, phylip
	10. Structure visualization using RASMOL
		20
		
		20

Module 2	Teacher Specific Module	5
	Directions	

Essential readings:

1. Altschul, S. F., Gish, W., Miller, W., Myers, E. W., & Lipman, D. J. (1990). Basic local alignment search tool. *Journal of Molecular Biology*
2. Thompson, J. D., Higgins, D. G., & Gibson, T. J. (1994). CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Research*

Suggested readings:

3. Jones, D. T. (1999). Protein secondary structure prediction based on position-specific scoring matrices. *Journal of Molecular Biology*
4. Altschul, S. F., Gish, W., Miller, W., Myers, E. W., & Lipman, D. J. (1990). Basic local alignment search tool. *Journal of Molecular Biology*
5. Bailey, T. L., & Elkan, C. (1994). Fitting a mixture model by expectation maximization to discover motifs in biopolymers. *Proceedings of the Second International Conference on Intelligent Systems for Molecular Biology*

Reference Distribution:

Module	Unit	Reference No.
1	1,2,3,4	1,2
	5,6,7,8	1,3,4
	9,10	3
	11,12	4,5

Assessment Rubrics

Evaluation Type		Marks(Theory)	Marks(practical)
End Semester Evaluation		**35**	**15**
Continuous Evaluation		**15**	**10**
a)	Test Paper/performance	5	5
b)	Assignment	5	-
c)	Seminar/viva/result	5	5
Total		**50**	**25**

- **Employability for the Course:**

- Biotechnology/IT companies
- Database developer
- Teaching
- Programme developer/analyst
- Bioinformatics software developer

KU8RPHBIF409: PROJECT

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	Advanced	KU8RPHBIF409	12	

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
12	6	0	40	60	100	3

Students are mandated to engage in a three to five-month-long individual project and present a dissertation summarizing their findings. This project is ideally conducted in a reputable external organization, such as national R&D institutions or global IT companies. Working within the college premises is permitted only under exceptional circumstances. The dissertation's evaluation and the viva-voce examination will be overseen by an external examiner appointed by the University. Apart from assessing the project work, the viva-voce will also evaluate the student's overall professional development and their generic subject awareness and knowledge through oral examination. The ESE of the project will be based on the dissertation (12 credits), its presentation and viva voce. The weightage from CE and ESE for Project /Dissertation work will be in the ratio of 40:60, with a total of 100.