M.Sc.

Bioinformatics

Course Curriculum

Academic Year: 2023-24

GSFC UNIVERSITY
EDUCATION RE-ENVISIONED

GSFC University, Vigyan Bhavan, P. O. Fertilizernagar, Vadodara - 391750, Gujarat, India

GSFCU strives to be the best compact boutique institution with a futuristic approach, encouraging student centric culture and sharpened focus on developing industry ready & employable students with all-round development.

MISSION

- Establish an institution, which promotes creativity and innovation.
- Develop unique quality standards for academic excellence and pedagogical innovations.
- Remain agile through learning ecosystem with flexible processes & systems.
- Holistic growth for industry readiness.

No.	Programme Outcomes (POs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PO1	To impart knowledge regarding basic concepts of Bioinformatics.	Basic Knowledge	Explain, Describe, Discuss, Recall, Locate
PO2	To explain the relationships between mathematics, computer science, and biology.	Interdisciplinary approach	Apply, Practice, Interpret, Select, Correlate
PO3	The efficient use of currently available tools to retrieve data from big databases and apply it to computer modelling.	Practical learning	Compare, Classify, Select, Investigate
PO4	To communicate effectively in terms of reading, writing, speaking and delivering the view to others.	Effective Communication and social Interaction	Explain, Describe, outline, Predict, Summarize

PO5	To culminate and understand the moral values for any of the subjects with respect to good practices and humanity.	Ethics	Judge, Assess, Estimate, Predict, Argue
PO6	The capacity to solve problems, including the creation of novel algorithms and analysis techniques.	Environment and Sustainability	Construct, Develop, Produce

No.	Programme Specific Outcomes (PSOs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PSO1	To understand the basic aspects of molecular biology, structural biology, genomics and proteomics with Bioinformatics interventions.	Remembering and Understanding	Explain, Describe, Discuss, Recall, Locate
PSO2	Expertise in interpreting complex data.	Application and Analysing	Apply, Practice, Interpret, Select, Correlate
PSO3	The efficient use of currently available tools to retrieve data from big databases and apply it to computer modelling.	Analysing	Compare, Classify, Select, Investigate
PSO4	The capacity to solve problems, including the creation of novel algorithms and analysis techniques.	Understanding	Explain, Describe, outline, Predict, Summarize

PSO5	Expertise in communicating issues related to big databases.	Evaluating	Judge, Assess, Estimate, Predict, Argue
PSO6	Expertise in solving complex social and ethical problems confronting the industry and the government.	Creating	Construct, Develop, Produce

Mapping of POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6
PSO 1	2	2	3	3	3	2
PSO 2	3	2	2	2	3	3
PSO 3	3	3	3	2	2	1
PSO 4	3	3	2	2	2	2
PSO 5	2	3	2	3	2	2
PSO 6	2	2	2	2	3	2
Avg.	2.5	2.5	2.3	2.3	2.5	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Definition of Credit:

1 Hour Lecture (L) per week	1 credit
1 Hour Tutorial (T) per week	1 credit
2 Hours Practical (P) per week	1 credit
1 Hour Practical (P) per week	0.5 credit
3 Hours Experiential learning	1 credit

Course code Definitions:

Lecture	L
Tutorial	T
Practical	P
Basic Science Courses	BSC
Engineering Science Courses	ESC
Humanities and Social Sciences including Management courses	HSMC
Professional core courses /Major (Core)	PCC
Professional Elective courses /Minor Stream	PEC
Open Elective courses	OEC

Laboratory course	LC
Mandatory courses	MC
Non-credit courses	NC
Project (Experiential learning)	PROJ
Experiential learning ex. Internship, Industrial Visit, Field visit, etc,	EL
Multidisciplinary courses	MDC
Ability Enhancement Course	AEC
Skill Enhancement Course	SCE
Value Added Courses	VAC

Structure of Postgraduate Programme:

Sr. No.	Category	Credit Breakup
1	Professional core courses -**Major (Core)**	61
2	Professional Elective courses relevant to chosen specialization/branch - **Minor Stream**	14

3	Project work, seminar and internship in industry or elsewhere	27
4	Mandatory Courses [Environmental Sciences, Induction Programme, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)
	Total	**102**

Table: Minimum Credit Requirement

Sr.No.	Broad Category of Course	**Minimum Credit Requirement**
		2-year PG
1	**Major (Core) (50% of total credit)**	**61**
2	**Skill Enhancement Courses (SEC) (from major & Minor)**	**12**
3	**Internship and Dissertation**	**27**
	Total	**102**

Semester- I

Sr. No.	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSBI111**	Advanced Biomolecules and Biochemistry	3	0	1	4	**150**
2.	**MSBI112**	Basics of Bioinformatics	3	0	1	4	**150**
3.	**MSBI113**	Mathematics for Bioinformatics and Biostatistics	3	0	1	4	**150**
4.	**MSBI114**	BioPython	2	0	1	3	**100**
5.	**MSBI115**	Molecular Diagnostics	2	0	0	2	**100**
6.	**MSBI116**	Medicinal Chemistry	2	0	0	2	**100**
7.	**MSBI116**	Internship	2	0	0	2	**50**

Semester- II

Sr.No	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSBI211**	Advanced cell and Molecular Biology	3	0	1	4	**150**
2.	**MSBI212**	Research Methodology & IPR	3	0	1	4	**150**
3.	**MSBI213**	Drug Discovery and development	3	0	1	4	**150**
4.	**MSBI214**	Basics of Computers	2	0	1	3	**100**
5.	**MSBI215**	Medical Informatics	2	0	0	2	**100**
6.	**MSBI216**	Microbial informatics	2	0	0	2	**100**
7.	**MSBI217**	Internship	2	0	0	2	**50**

Semester- III

Sr.No	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSBI311**	Project proposal preparation	3	0	1	4	**150**
2.	**MSBI312**	Emerging Technology	3	0	1	4	**150**
3.	**MSBI313**	AI and Bioinformatics	3	0	1	4	**150**
4.	**MSBI314**	Introduction to Systems Biology	2	0	1	3	**100**
5.	**MSBI315**	Immunoinformatics	2	0	0	2	**100**
6.	**MSBI315**	Agriinformatics	2	0	0	2	**100**
7.	**MSBI316**	Internship	2	0	0	2	**50**

Semester- IV

Sr.No	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSBI411**	Dissertation and Viva			20	20	**600**

About the Programme:

Master of Science in Bioinformatics is a two year Post graduate professional course primarily aimed for students from diverse sections of science to understand various biological processes, design new drugs etc by harnessing the power of the computers. The course is designed to make the graduate students ready for exciting careers in post genomic era. High end computation and computational modelling would drive the biological research to new heights in the future making this course more relevant in this era.

Bioinformatics, is an interdisciplinary field of science that is at the interface of biology, chemistry and computer sciences. This field of science develops methods and software tools for storing, retrieving, organising and analysing biological data, by combining computer science, statistics,

mathematics to study and process biological data. Mapping, measuring and engineering of molecules, cells, tissues and organs, bio-machines and biocomputing would show their impact on various fields like various fields like health, agriculture, consumer goods and energy effecting societies and economies.This course would not only cover the technical aspects of bioinformatics but also emphasize on imparting practical skills that would cater to the needs of next generation of industries and startups.

Teaching Scheme Semester – I M. Sc Bioinformatics

Sr. No.	Course Code	Course Name	Teaching Scheme (Hours/week)				Teaching Credit				Evaluation Scheme					
			L	P	T	Total	L	P	T	Total	Theory:MS Marks	Theory: CEC Marks	Theory: ES Marks	Theory Marks	Practical Marks	Total Marks
	Course															
1	**MSBI111**	Advanced Biomolecules and Biochemistry	3	0	0	45	3	1	0	4	20	40	40	100	50	150
2	**MSBI112**	Basics of Bioinformatics	3	0	0	45	3	1	0	4	20	40	40	100	50	150
3	**MSBI113**	Mathematics for Bioinformatics and Biostatistics	3	0	0	45	3	1	0	4	20	40	40	100	50	150
4	**MSBI114**	BioPython	3	0	0	45	3	1	0	4	20	40	40	100	50	150
5	**MSBI115**	Molecular Diagnostics	2	0	0	30	3	1	0	2	20	40	40	100		100
6	**MSBI116**	Medicinal Chemistry	2	0	0	30	3	1	0	2	20	40	40	100		100
7	**MSBI117**	Internship	0	0			0	2	0	2				50		

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

Teaching Scheme Semester – II M. Sc Bioinformatics

Sr. No.	Course Code	Course Name	Teaching Scheme (Hours/week)				Teaching Credit				Evaluation Scheme					
			L	P	T	Total	L	P	T	Total	Theory: MS Marks	Theory: CEC Marks	Theory: ES Marks	Theory Marks	Practical Marks	Total Marks
	Course															
1	**MSBI211**	Advanced cell and Molecular Biology	3	0	0	45	3	1	0	4	20	40	40	100	50	150
2	**MSBI212**	Research Methodology & IPR	3	0	0	45	3	1	0	4	20	40	40	100	50	150
3	**MSBI213**	Drug Discovery and development	3	0	0	45	3	1	0	4	20	40	40	100	50	150
4	**MSBI214**	Basics of Computers	3	0	0	45	3	1	0	4	20	40	40	100	50	150
5	**MSBI215**	Medical Informatics	2	0	0	30	2	0	0	2	20	40	40	100	00	100
6	**MSBI216**	Microbial informatics	2	0	0	30	2	0	0	2	20	40	40	100	00	100
7	**MSBI217**	Internship	0	0			0	2	0	2				50		

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

Teaching Scheme Semester – III M. Sc Bioinformatics

Sr. No.	Course Code	Course Name	Teaching Scheme (Hours/week)				Teaching Credit				Evaluation Scheme					
			L	P	T	Total	L	P	T	Total	Theory: MS Marks	Theory: CEC Marks	Theory: ES Marks	Theory Marks	Practical Marks	Total Marks
	Course															
1	**MSBI311**	Project proposal preparation	3	0	0	45	3	1	0	4	20	40	40	100	50	150
2	**MSBI312**	Emerging Technology	3	0	0	45	3	1	0	4	20	40	40	100	50	150
3	**MSBI313**	AI and Bioinformatics	3	0	0	45	3	1	0	4	20	40	40	100	50	150
4	**MSBI314**	Introduction to Systems Biology	3	0	0	45	3	1	0	4	20	40	40	100	50	150
5	**MSBI315**	Immunoinformatics	2	0	0	30	2	0	0	2	20	40	40	100	00	100
6	**MSBI316**	Agriinformatics	2	0	0	30	2	0	0	2	20	40	40	100	00	100
7	**MSBI317**	Internship	0	0			0	2	0	2				50		

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

COURSE CODE MSBI111	COURSE NAME ADVANCED BIOMOLECULES AND BIOCHEMISTRY	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	1	0	75	3	1	0	4

Course Pre-requisites	Students should have basic knowledge about advanced biomolecules and biochemistry
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	Advanced biomolecules and biochemistry are vital for students as they provide a comprehensive understanding of the molecular basis of life processes, laying the foundation for research and innovation in biotechnology, medicine, and drug discovery, thereby preparing students for careers in academia, industry, and healthcare.
Course Revision/ Approval Date:	06-03-2024
Course Objectives (As per Blooms' Taxonomy)	**1. Remember** To introduce the field of advanced biomolecules and biochemistry. **2. Apply** To understand advanced biomolecules and biochemistry. **3. Analyses** Understanding of advanced biomolecules and biochemistry **4. Create** Understanding of strategies to study advanced biomolecules and biochemistry **5. Understand** advanced biomolecules and biochemistry

Course Content (Theory)	Weightage	Contact hours
Unit 1: Carbohydrate and its metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 2: Protein and amino acid and it's metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 3: Lipids and it's metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 4: Nucleic acid and it's metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 5: Cell membrane: It's integrity, complexity and molecular structure.	**20%**	**9**

Practicals:

1. Preparing various stock solutions and working solutions that will be needed for the course.
2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
3. To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbeck Equation.
4. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography.
5. Purification and characterization of an enzyme from a recombinant source
6. Experimental verification that absorption at OD_{260} is more for denatured DNA as compared to native double stranded DNA.
7. Reversal of the same following DNA renaturation. Kinetics of DNA renaturation as a function of DNA size.
8. Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. (Optional Experiments)
9. Biophysical methods (Circular Dichroism Spectroscopy, Fluorescence Spectroscopy).
10. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry.

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1** They will be able to recall and describe key biochemical pathways and processes involved in metabolism, signaling, and regulation within living organisms.	Remember	Explain, Describe, Discuss, Recall,
CO2 They will demonstrate the ability to summarize and compare different biochemical processes and their significance in cellular function and organismal physiology.	Apply	Interpret, Select,
CO3 Students will critically evaluate scientific literature and research findings related to advanced biomolecules and biochemistry, identifying strengths, weaknesses, and gaps in existing knowledge.	Analyses and Evaluation	Compare, Classify, Select,
CO4 Utilizing their knowledge of biomolecules and biochemical principles, students will analyze experimental data and design experiments to investigate biological questions or solve practical problems.	Create	Construct, Develop,
CO5 They will demonstrate creativity and innovation in problem-solving, synthesizing information to generate new insights or applications in biotechnology, medicine, or other relevant fields.	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources	
1.	Textbook & Reference Books 1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006).Biochemistry. VI Edition. 2. W.H Freeman andCo. 2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists. 3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, US 4. A.L. Lehninger: Biochemistry.
2.	Journals & Periodicals 1. JBC 2. Current Science
3	Other Electronic resources: NPTEL

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Skill enhancement activities / case study</td><td>15 marks</td></tr>
<tr><td>Presentation/ miscellaneous activities</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
</table>
</td></tr>
<tr><td>Practical Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>30 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>5 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI112	COURSE NAME BASICS OF BIOINFORMATICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	1	0	75	3	1	0	4

Course Prerequisites	Basic Knowledge of computers
Course Category	Core
Course focus	Scientific Temperament & Employability
Rationale	Know how to develop your skills in Python Retrieve and analyze the biological data
Course Revision/ Approval Date:	06-03-2024
Course Objectives (As per Blooms' Taxonomy)	• **To Remember** the basic concepts of python • **Understand** to edit and run Python code • **To analyze and evaluate** file-processing python programs that produce output to the terminal and/or external files • **Apply** the knowledge of python to analyse the biological data • **To Create** stand-alone python programs to process biological data

Course Content Theory) Bioinformatics	**Weigh tage**	**Contact hours**
Unit 1: Introduction to Bioinformatics , applications and biological databases Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XMLDTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools.	**20%**	**9**
Unit 2: Pair wise alignment: Introduction, Dot Plot, Dynamic Programming, K-tuple, Fasta, Blast, Other Tools and Softwares. where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating	**20%**	**9**
Unit 3: Multiple sequencing alignment: Introduction, Dynamic Programming; Progessive, Iterative, Marakov, HMM Methods, CLUSTALW, Other Tools and Softwares flexible sequence similarity searching with the FASTA program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment	**20%**	**9**

Unit 4: Phylogenic Analysis: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; Origin of new genes and proteins; Gene duplication and divergence. Phylogenetic representations, Definition and description, various types of trees; Steps in constructing a tree, Consensus (strict, semi-strict, Adams, majority rule, Nelson). Data partitioning and combination. Tree to tree distances, similarity. Phylogenetic analysis algorithms: Maximum Parsimony, UPGMA, Transformed Distance, Neighbors-Relation, Neighbor-Joining, jackknife, Probabilistic models and associated algorithms such as Probabilistic models of evolution and maximum likelihood algorithm, Bootstrapping methods. Use of HMM-based Algorithm for MSA	**20%**	**9**
Unit 5: Data ethics and Database: Data ethics, Introduction to Databases, DBMS Definition, Characteristics of DBMS, Application and advantages of DBMS, Instances, Schemas and Database States, Three Levels of Architecture, Data Independence, DBMS languages, Data Dictionary, Database Users, Data Administrators.	**20%**	**9**
Practicals: 1. Retrieving sequences from public databases (e.g., NCBI GenBank, UniProt). 2. Performing sequence similarity searches using tools like BLAST (Basic Local Alignment Search Tool). 3. Pairwise sequence alignment (e.g., global alignment, local alignment) using tools such as EMBOSS Needle or BLAST. 4. Multiple sequence alignment (e.g., using ClustalW, MUSCLE) to align multiple sequences for comparative analysis. 5. Identifying open reading frames (ORFs) in nucleotide sequences. 6. Predicting protein structure and function from amino acid sequences using tools like InterProScan or Pfam. 7. Constructing phylogenetic trees using various methods (e.g., Neighbor-Joining, Maximum Likelihood).		

Learning Resources	
1.	**Textbook & Reference Book** 1. Lesk,A.M.(2002).IntroductiontoBioinformatics.Oxford:OxfordUniversityPress. 2. Mount, D. W.(2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring 3. Harbor, NY: Cold Spring Harbor Laboratory Press. 4. Baxevanis, A. D.,& Ouellette, B. F.(2001). Bioinformatics: a Practical Guide to the 5. Analysis of Genes and Proteins. New York:Wiley-Interscience. 6. Pevsner,J.(2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell
2.	**Journals & Periodicals** 1. Journal of Bioinformatics and Computational Biology 2. Bioinformatics 3. Bioinformatics and Biology Insights 4. BMC Bioinformatics 5. Briefings in Bioinformatics

3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Evaluation Scheme		**Total Marks 100**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	10 marks
	Skill enhancement activities / case study	10 marks
	Presentation/ miscellaneous activities	15 marks

Course Outcomes	1.Develop an understanding of basic theory of biological databases.
	2. Appreciate their relevance for investigating specific contemporary biological questions through the use of bioinformatics tools
	3. Critically analyse and interpret results of bioinformatic analysis
	4. Develop the abilities for conducting in silico experiments.
	5. Demonstrate mastery of the core concepts of Bioinformatics
Additional Information to enhance learning	Expert talk required on specific topics.

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI113	COURSE NAME MATHAMATICS FOR BIOINFORMATICS AND BIOSTATISTICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	0	1	45	3	0	1	4

Course Prerequisites	Basic knowledge of Mathematics
Course Category	Core
Course focus	Scientific Temperament & Employability

Rationale	Mathematics provides the essential tools and methods for analyzing complex biological data, developing algorithms, and drawing robust statistical inferences in bioinformatics and biostatistics.
Course Revision/ Approval Date:	06-03-2024
Course Objectives (As per Blooms' Taxonomy)	1. Recall fundamental mathematical concepts and techniques used in bioinformatics 2. Comprehend and interpret mathematical principles relevant to bioinformatics 3. Apply mathematical methods to solve bioinformatics problems 4. Analyze complex biological data using mathematical techniques 5. Critically evaluate the effectiveness of mathematical models in bio informatics

Course Content Theory)	**Weigh tage**	**Contac t hours**
Unit1: Basic Mathematics: Introduction to function, Types of functions. Total and Partial derivative of functions, Basic rules for finding the derivatives, Integration of a function, Basic rules for finding integration, Definite integration,Introduction to ordinary and partial differential equation,Vectors: Vector algebra, Dot and Cross products,Matrices: Algebra of Matrices, Transpose and inverse, Digonalization of Matrices and Characteristic roots	**20%**	**9**
Unit 2: Statistical Measures: Population, Sample, Primary and Secondary Data Representation and Classification of Data; Frequency Distribution, Tabulation and Graphical Representations, Majors of Central tendency: Mean, Geometric Mean, Harmonic Mean, Median and Mode, Quartiles and Percentiles and Measures of dispersion: Range, Variance, Standard Deviation,and Coefficient of Variation	**20%**	**9**
Unit 3: Probability and Theoretical Distribution: Definitions of Probability, Sample space, events, types of events. Calculation of probability, Theorems of probability: Addition and Multiplication theorem, Conditional probability, Bayes' theorem, Random variable, Distributions of random variables, Binomial, Poisson, Geometric, Normal distribution and their applications in Bioscience.	**20%**	**9**
Unit 4: Correlation Analysis and Regression Analysis: Types of correlation, Methods of studying simple correlation: Scatter Diagram, Karl Pearson's Co-efficient of Correlation, Spearman's Rank Correlation, Uses of Regression Analysis, Types of Regression, Difference between Correlation and Regression Analysis, Regression lines, Simple and Multiple Linear Regressions using Least SquarePrinciple	**20%**	**9**
Unit 5: Statistical Inference-Tests of Hypothesis and Analysis of Variance (ANNOVA).Simple and composite hypotheses ,Null and alternative hypotheses, critical region, Type I and Type II errors, Level of significance, p- value, power of a test, Test of significance viz. Z test, t test, pair t test for large and small samples, Parametric and non parametric tests.The Goodness of-Fit Test; Chi Square Test, F-test.	**20%**	**9**

Tutorials:

1. Probability theory (e.g., conditional probability, Bayes' theorem).
2. Statistical distributions (e.g., normal distribution, Poisson distribution).
3. Statistical inference (e.g., hypothesis testing, confidence intervals).
4. Matrix operations and properties.
5. Eigenvalues and eigenvectors.
6. Matrix decomposition methods (e.g., SVD, PCA).

Evaluation Scheme		**Total Marks 100**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	10 marks
	Skill enhancement activities / case study	10 marks
	Presentation/ miscellaneous activities	15 marks
Course Outcomes	CO1: Use the measures of central tendency dispersion on a given data and determine different statistical measures for the data CO2: Use correlation and linear regression methods to find a relationship and good of fit for the given data CO3: Perform hypothesis testing on small and large data samples using appropriate parametric and non-parametric test. CO4: Perform statistical hypothesis testing by selecting an appropriate testing procedure for the given analysis. Estimate confidence intervals for a statistical parameter CO5: Calculate probabilities and estimate parameters for various outcomes/events following different probability distributions	
Additional Information to enhance learning	Expert talk required on specific topics.	

Learning Resources	
1.	**Textbook & Reference Book** 1. Basic Mathematics by Serge A. Lang. Springer Publisher. 1988 2. A First Course in Calculus by Serge A. Lang. Springer publisher. 1986 3. Higher Engineering Mathematics (40th Ed), by B.S. Grewal and J.S. Grewal. Khanna Publishers, New Delhi. 2007. 4. Statistical Methods by Dr. S P Gupta, Sultan Chand & Sons 46th Edition
2.	**Journals & Periodicals** 6. Statistical Methods in Medical Research 7. Journal of Epidemiology and Biostatistics
3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	0	0	0
CO2	1	2	0	0	0
CO3	1	2	0	0	0
CO4	2	2	1	0	0
CO5	2	3	0	1	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5

CO1	2	2	1	1	0
CO2	2	2	1	1	0
CO3	1	2	1	1	0
CO4	2	2	2	1	1
CO5	2	2	1	1	1

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSBI114	BIOPYTHON	I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	1	0	75	3	1	0	4

Course Prerequisites	Basic Knowledge of computers
Course Category	Specialization
Course focus	Scientific Temperament & Employability
Rationale	Know how to develop your skills in Python Retrieve and analyze the biological data
Course Revision/ Approval Date:	06-03-2024
Course Objectives (As per Blooms' Taxonomy)	• **To Remember** the basic concepts of python • **Understand** to edit and run Python code • **To analyze and evaluate** file-processing python programs that produce output to the terminal and/or external files • **Apply** the knowledge of python to analyse the biological data • **To Create** stand-alone python programs to process biological data

Course Content (Theory)	Weigh tage	Contact hours
Unit 1 Execution paradigms: how the computer turns your program into something it can run (interpretation, native compilation, bytecode compilation) Basic execution and memory model (Von Neumann architecture), Version control (likely SVN and git)	**20%**	**9**
Unit 2 Imperative programming constructs: functions, if-statements, loops (for, while), switchstatements, expressions. Basic data structuring constructs: variables, arrays, strings, structs, types, and pointers, Reading and writing files	**20%**	**9**
Unit 3: Unit tests — testing small sections of code,Debugging — strategies, debuggers, common errors Profiling — figuring out what's taking so long, Make — automating compilation, Basic data structures and algorithm design techniques: Sophisticated data structures,and algorithms will be introduced, along with more difficult programming assignments.	**20%**	**9**
Unit 4: Linear data structures: arrays, lists, stacks, queues; binary search,Dictionary data structures: binary search trees including tree traversals (DFS, BFS,pre-, in-, post-order); hash tables.	**20%**	**9**

Unit 5: Heaps, heapsort,Graphs; MST, Divide and conquer, recursion Dynamic programming	**20%**	**9**

List of practical
Variable creation and assignment
Basic arithmetic operations
Basic string-manipulation operations
File input/output
Formatted print statements
Control-flow statements
Loops and lists

Learning Resources	
1.	**Textbook & Reference Book** 1) Python: - The Bible- 3 Manuscripts in 1 Book: -Python Programming for Beginners -Python Programming for Intermediates -Python Programming for Advanced by Maurice J Thompson 2) Learning python (5th Edition) by Mark Lutz, O'Reilly Media, Inc (2013). ISBN:9781449355739 3) Python programming for biology by Tim J. Stevens and Wayne Boucher. Cambridge University Press 1st Ed. (2015) ISBN:9780511843556
2.	**Journals & Periodicals**
3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Course Outcomes	1.Develop an understanding of basic theoretical concepts of Python.
	2. Appreciate their relevance for investigating specific contemporary biological questions through the use of Biopython
	3. Understand the concepts of object-oriented programming as used in Python
	4. Learn Biopython to enhance your skills for conducting in silico experiments.
	5. Demonstrate mastery of the core concepts of Bioinformatics
Additional Information to enhance learning	Expert talk required on specific topics.

<table>
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<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Skill enhancement activities / case study</td><td>15marks</td></tr>
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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI115	COURSE NAME MOLECULAR DIAGNOSTICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
2	0	0	30	2	0	0	2

Course Pre-requisites	Students should know have basic knowledge of molecular diagnostics.
Course Category	**Elective**
Course focus	Elective
Rationale	Scientific Temperament & Employability
Course Revision/ Approval Date:	6/03/2024
Course Objectives (As per Blooms' Taxonomy)	1. The objectives of this course are to sensitize students about recent advances in diagnostics and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including preor post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer 2. Adequate knowledge about recent advances and technological developments in the field of diagnostics 3. Selection of an appropriate diagnostic method/tool for a particular disease condition and sample type. 4. Expertise to perform any diagnostic test with an ability to troubleshoot. 5. The objectives of this course are to sensitize students about recent advances in molecular biology.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Molecular Diagnostics	**20%**	**10**
Unit 2: Nucleic Acid Amplification Techniques	**20%**	**10**
Unit 3: Regression Analysis: Simple linear regression, Multiple linear regression, Logistic regression, Model diagnostics and interpretation	**20%**	**10**
Unit 4: Survival Analysis: Kaplan-Meier estimator, Cox proportional hazards model, Survival curves and censoring, Applications in clinical trials and epidemiological studies.	**20%**	**10**
Unit 5: Diagnostic Assays for Infectious Diseases and Epidemiological Study Designs: Observational studies vs. experimental studies, Cross-sectional studies, Cohort studies, Meta-analysis	**20%**	**05**

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to: **CO1** Able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases	Understand, Remember& apply	Explain, Describe, Discuss, Recall, Locate

CO2 Acquire knowledge of various diagnostic tools used in healthcare, industry and research **CO3** Identify the role and importance of molecular diagnostics such as real-time PCR, epidemiological genotyping, microfluidics, bio-imaging and sequencing technologies **CO4** Students will be able to Incorporate both in silico and lab based techniques as part of a combined molecular diagnostics strategy. **CO5** Perform selected laboratory techniques, interpret results and prepare reports	Apply Evaluate Apply Understand, Remember& apply	Apply, Practice, Interpret, Select, Correlate Compare, Classify, Select, Investigate Construct, Develop, Produce Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook 1. Campbell, A. M., & Heyer, L. J. (2006). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings. 2. Brooker, R. J. (2009). Genetics: Analysis & Principles. New York, NY: McGraw- Hill. 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, DC: ASM Press. 4. Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press.
2	Reference book : Molecular Diagnostics, 3rd Edition Editors: George P. Patrinos Wilhelm Ansorge Phillip B. Danielson. Hardcover ISBN: 9780128029718. eBook ISBN: 9780128029886
3	Journal : Journal of Molecular Diagnostics, Nature reviews
5	Periodicals: Current science
6	Other Electronic resources: NPTL and UGC Pathshala lectures

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Mapping of PSOs and COs

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CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI116	COURSE NAME MEDICINAL CHEMISTRY	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	2	2	0	0	2

Course Pre-requisites	Students should know have basic knowledge of molecular diagnostics.
Course Category	Elective
Course focus	Elective
Rationale	Scientific Temperament & Employability
Course Revision/ Approval Date:	6/03/2024
Course Objectives (As per Blooms' Taxonomy)	To sensitize students about recent advances in diagnostics and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre or post-natal analysis of genetic diseases. Identification of individuals predisposed to disease ranging from common cold to cancer.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction and history of medicinal chemistry. Physico chemical properties in relation to Biological actions	**20%**	**10**
Unit 2: Stereochemistry of drug action: Introduction and importance of stereochemistry in drug action, chirality and enantiomers.	**20%**	**10**
Unit 3: Classification of Drugs. Drugs acting on the Central Nervous System. Drugs acting on Autonomic Nervous System	**20%**	**10**
Unit 4: Structure activity relationship of various drug molecules	**20%**	**10**
Unit 5: Drug metabolism Drug metabolism principles- Phase I and Phase II. Factors affecting drug metabolism including stereo chemical aspects	**20%**	**10**

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to:		Explain, Describe, Discuss, Recall, Locate
CO1 Able to understand medicinal chemistry.	Understand, Remember & apply	
CO2 Acquire knowledge of various drug targets.	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 Able to evaluate	Evaluate	Compare, Classify, Select, Investigate
CO4 Students will be able to Incorporate both in silico and lab-based techniques.	Apply	Construct, Develop, Produce Explain, Describe, outline, Predict, Summarize
CO5 Study medicinal chemistry	Understand, Remember & apply	

Learning Resources	
1	Textbook Medicinal Chemistry by Ashutosh Kar
2	Reference book :
3	Journal : Journal of Medicinal Chemistry
5	Periodicals:
6	Other Electronic resources: NPTL and UGC Pathshala lectures

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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI211	COURSE NAME ADVANCED CELL AND MOLECULAR BIOLOGY	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	1	0	75	3	1	0	4

Course Pre-requisites	Students should know have basic knowledge of Cell and Molecular Biology
Course Category	Compulsory
Rationale	As we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomesdeeper and inclusive.
Course Revision/ Approval Date:	6/03/2024
Course Objectives (As per Blooms' Taxonomy)	**Remember** To introduce the advanced field of cell and molecular biology. **Apply** To understand advanced cellular and molecular functions. **Analyses** Underlying mechanisms of cellular and molecular functions. **Create** Understanding of strategies to develop drugs based on gained knowledge. **Understand** Drugs discovery and development based on basic cellularfunctions.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Cellular Membranes and Organelles	**20%**	**10**
Unit 2: Gene Expression and Regulation	**20%**	**10**
Unit 3: Signal Transduction Pathways	**20%**	**10**
Unit 4: Molecular Genetics	**20%**	**10**
Unit 5: Cell Cycle Regulation and Cell Division, Stem Cells and Regenerative Medicine	**20%**	**10**

Practicals:

1. Genomic DNA Extraction, Purification and Quantitation
2. Plasmid DNA Extraction, Purification and Quantitation
3. RNA Extraction, Purification and Quantitation
4. Protein Extraction,
5. Protein Purification
6. Protein Quantitation

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy	Blooms' Taxonomy Sub
	Domain	**Domain**
After successful completion of the above course, students will be able to: **CO1** The structure, function, and biosynthesis of cellular membranes and organelles.	Understand, Remember & apply	Explain, Describe, Discuss, Recall, Locate

CO2 Cell growth and cell cycle regulation	Apply	Apply, Practice, Interpret,
CO3 Cellular transport, receptors, and cell signaling	Evaluate	Select, Correlate
CO4 The cytoskeleton, the extracellular matrix, and cell movements	Apply	Compare, Classify, Select,
CO5 Gene expression and regulation	Understand, Remember & apply	Investigate Construct, Develop, Produce Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook 1. Alberts, B., Johnson, A., Lewis, J.,Raff, M., Roberts, K., & Walter,P.(2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science. 2. Lodish, H. F.(2016). Molecular Cell Biology (8thEd.). New York:W.H.Freeman. 3.Krebs,J.E.,Lewin,B.,Kilpatrick,S.T.,& Goldstein,E.S.(2014).Lewin'sGenesXI. Burlington, MA: Jones & Bartlett Learning. 4.Cooper,G.M.,&Hausman,R.E.(2013).TheCell:aMolecularApproach(6thEd.). Washington: ASM ; Sunderland. 5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W.M. (2012). Becker's World of the Cell. Boston (8th Ed.). BenjaminCummings. 6. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings. Reference books 1. Karp, G. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. 2. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology. VIII Edition. 3. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. V Edition. ASMPress
2	Journals & Periodicals Journal https://www.omicsonline.org/cellular-and-molecular-biology.php 1. Resonance 2. Current Science 3. Science Reporter 4. Safari
3	Other Electronic resources: 1) MH Education 2) NPTEL E- Links 1. The Inner Life of the Cell

	2. Mitosis World Movies 3. Davidson College Biology Videos 4. Borisy Lab Movie Page 5. The Biology Project Meiosis I and II Movies

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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI212	COURSE NAME RESEARCH METHODOLOGY AND IPR	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	1	0	75	3	1	0	4

Course Pre-requisites	Basic Understanding of Science and Communication.
Course Category	Compulsory
Course focus	Employability
Rationale	To have an idea how research methodology lies in its ability to provide a systematic approach to investigating and answering research questions. It serves as a roadmap for researchers, helping them design and conduct their studies effectively and ensure the validity and reliability of their findings. Here are a few key points that highlight the rationale behind research methodology
Course Revision/ Approval Date:	06/03/24
Course Objectives **(As per Blooms' Taxonomy)**	**Remember:** To give background on history of science, emphasizing methodologies used to do research and India's IPR Policy. **Apply:** To introduce the framework of research methodologies for understanding effective lab practices and scientific communication and intellectual property rights and their implications in biological research and product development. **Analyses:** To inculcate scientific and professional ethics to learn biosafety and risk assessment of biotechnology products **Create:** To impart skills related to various media for scientific communication and regulations of products derived from biotechnology **Understand:** To impart basic knowledge of lab skills to learn risk assessment on biotechnology and microbiology, become familiar with ethical issues in biological research.

Course Content (Theory)	Weightage	Contact hours

Unit 1: Introduction to Research Methodology: Definition and importance of research, Types of research (qualitative, quantitative, mixed methods), The research process (formulating research questions, hypothesis, etc.) Ethical considerations in research	**20%**	**9**
Unit 2: Research Design: Experimental design Quasi-experimental design, Non-experimental design	**20%**	**9**
Unit 3: Sampling Techniques, Data Collection Methods and Analysis, research writing and ethics.	**20%**	**9**
Unit 4: Introduction To Intellectual Property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs	**20%**	**9**
Unit 5: International Framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction history of GATT, WTO, WIPO and TRIPS	**20%**	**9**

Practicals:

1. Discussing ethical considerations in research involving human subjects, animals, and biohazards.
2. Understanding regulatory requirements (e.g., IRB approval, animal care protocols).
3. Conducting literature searches using databases like PubMed, Google Scholar.
4. Critical evaluation and synthesis of scientific literature relevant to a research topic.
5. Formulating testable hypotheses based on literature review and research questions.
6. Designing experiments to test hypotheses, including control and experimental group considerations.

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1** To become familiar with India's IPR Policy, and research methodology	Remember	Explain, Describe, Discuss, Recall, Locate
CO2 To provide basic knowledge on intellectual property rights andtheir implications in biological research and product development and	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 To learn biosafety and risk assessment of biotechnology products and learn about research methodology and to inculcate scientific and professional ethics	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To become familiar with regulations of products derived frombiotechnology and to learn about research methodology	Create	Construct, Develop, Produce
CO5 To learn risk assessment on biotechnology and microbiology, become familiar with ethical issues in biological research,	Understand	Explain, Describe, outline, Predict, Summarize

Learning Resources

1.	On Being a Scientist: a Guide to Responsible Conduct Research. (2009). Washington, D.C.: National Academies Press. Gopen, G. D., & Smith, J.A. The Science of Scientific Writing. American Scientist,78 (Nov-Dec 1990), 550-558. Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press. Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India.
2.	Ganguli,P.(2001).Intellectual Property Rights: Unleashing TheKnowledge Economy. New Delhi: Tata McGraw-Hill Pub National IPR Policy, Department ofIndustrial Policy & Promotion, Ministry of Commerce, GoI
5	Complete Reference to Intellectual Property Rights Laws. (2007). Snow White PublicationOct. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell. Karen F.Greif and Jon F. Merz, Current Controversies in the Biological Sciences - Case Studies of Policy Challenges from New Technologies, MIT Press. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J.W., Burachik, M., Gray, A., Wu,F.

	(2009). Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9 Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). An Overview of General Features Of Risk Assessments of Genetically Modified Crops. Euphytica, 164(3), 853-880. doi:10.1007/s10681-007- 9643-8 Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008. Journals & Periodicals 1. International Journal of Research Methodology 2. International Journal of Science and Research Methodology 3. The WIPO Journal Periodicals: Journal of Research Practice • Other Electronic resources: Movies: Naturally Obsessed, The Making of a Scientist • Office the Controller General Patents, Designs & Trademarks; Department Of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/ 2. World Intellectual PropertyOrganisation. http://www.wipo.int 3. International Union for the Protection of New Varieties of Plants. http://www.upov.int 4. World Trade Organisation. http://www.wto.org 5. National Portal of India. http://www.archive.india.gov.in 6. • National Biodiversity Authority. http://www.nbaindia.org 7. Recombinant DNA SafetyGuidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/ divisions/csurv/geac/annex- • 5.pdf

Evaluation Scheme	Total Marks

Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Skill enhancement activities / case study: 15 marks Presentation/ miscellaneous activities: 10 marks **Total: 40 Marks**
Practical Marks	Attendance: 5 marks Practical Exam: 30marks Viva: 5 marks Journal: 5marks Discipline: 5marks **Total: 50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	2	-	2	1	1	-
CO2	1	-	2	2	-	-
CO3	-	-	-	1	2	1
CO4	1	3	2	-	2	1
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	-	2	-	2	2	1
CO2	1	2	1	2	-	-
CO3	2	-	-	1	-	1
CO4	1	1	2	-	2	2
CO5	-	1	-	2	-	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE BSBI214	COURSE NAME PROGRAMMING FOR BIOLOGISTS	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	1	0	75	3	1	0	4

Course Prerequisites	Acquaintance with Basic concepts of computers
Course Category	Specialization
Course focus	Skill development
Rationale	Utilise the UNIX/LINUX environment effectively to perform a range of system-level tasks
Course Revision/ Approval Date:	06-03-2024
Course Objectives (As per Blooms' Taxonomy)	Install and Run Unix commands Install R and RStudio. Write simple pseudocode and create simple flow charts. Document your code and Use file management and version control tools. Perform simple arithmetic and statistical operations in R.

Course Content (Theory) Basics of Computing	Weightage	Contact hours
Unit 1 Introduction To Linux, History and design, Principles of Linux, Functions of Linux OS, Basic shell commands, Understanding Linux file permissions, Basic script building, File creation in Linux SQL, HTML and XML, Programming Language R, Overview of R, R data types and objects, reading and writing data- Control structures, functions	**20%**	**6**
Unit 2 Programming Language R, Overview of R, R data types and objects, reading and writing data- Control structures, functions	**20%**	
Unit 3 SQL: Select statement Data definition statement; Data Manipulation Statements Data Control Statement Other Database Objects (Views, Sequences, Synonyms); Introduction to Application Program Executor; Standard Controls; Data Access Using data Control Connecting to Oracle	**20%**	**6**
Unit 4: Introduction to VB.NET, Understanding the development Environment – IDE Components. Data Types – Variables – Conditional and Looping Statements – Modular Coding – Subroutines – Functions – Argument-Passing. - Application development using VB.NET framework- Working with Forms-Components, Controls and Their Properties, Methods and	**20%**	**6**

Events.		
Unit 5: ADO.NET: overview - Architecture - DataSet - DataGrid Control- File I/0 Operations Introduction to database connectivity: Data Access with ADO.NET-Binding Controls to Databases- Handling Databases in Code	**20%**	**6**

List of Practical
To provide introduction to UNIX Operating System and its File System
To gain an understanding of important aspects related to the SHELL and the process
To develop the ability to formulate regular expressions and use them for pattern matching.
To provide a comprehensive introduction to SHELL programming, services and utilities
Getting Started With R
Functions And Statements
Data Manipulation and Analysis

Learning Resources	
1.	**Textbook & Reference Book** 1) Introduction to Database Systems. C.J.Date 2) Introduction to Database Systems. J.M.Martin, Princeton-Hall. 3) Using Microsoft Visual Basic.NET. Brian Siler and Jeff Spotts, Pearson Education 4) The Design Of UNIX Operating System : Maurice . J. Bach. 5) Advance Programming In UNIX Environment : Richard. W. ... 6) UNIX Programming Environment : B. W. Kernighan and Rob Pike.
2.	**Journals & Periodicals** Journal of Bioinformatics and Computational Biology Journal of Computational Biology
3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Evaluation Scheme		**Total Marks 100**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	10 marks
	Skill enhancement activities / case study	15 marks
	Presentation/ miscellaneous activities	10marks

Course Outcomes	1.Develop an understanding of basic theoretical concepts of Python.
	2. Appreciate their relevance for investigating specific contemporary biological questions through the use of Biopython
	3. Understand the concepts of object-oriented programming as used in Python
	4. Learn Biopython to enhance your skills for conducting in silico experiments.
	5. Demonstrate mastery of the core concepts of Bioinformatics
Additional Information to enhance learning	Expert talk required on specific topics.

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE BSBI215	COURSE NAME MEDICAL INFORMATICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	30	2	0	0	2

Course Prerequisites	Students should have basic knowledge of medical bioinformatics
Course Category	Elective
Course focus	Scientific Temperament & Employability
Rationale	1. To provide overview of Biomedical Informatics and Health Information Technology 2. Introduce the student to the major areas of the evolving discipline 3. Understand the application of health information technology for healthcare delivery, education and research as well as the multidisciplinary nature of biomedical informatics
Course Revision/ Approval Date:	6/03/2024
Course Objectives (As per Blooms' Taxonomy)	**1. To Remember** Concepts of basic Bioinformatics **2. To Analyses and evaluate** the rationale behind using softwares and tools for biological data analysis **3. To Create** an understanding on developing various bioinfomatic databases and tools **4. To Understand** various algorithms underlying bioinformatic analysis of biological data **5. To Apply** the knowledge of bioinformatics in both scientific and industrial research.

Course Content (Theory)	Weigh tage	Contact hours
Unit 1 Introduction to Medical Informatics.It describes the use of data, information and knowledge in improving healthcare and biomedical research. This includes the use of technology and computers to store, retrieve, and process data. Topics include clinical decision making, standards and clinical terminology, natural language processing, imaging, electronic health records, patient monitoring, consumer health informatics, public health informatics, clinical decision support, bioinformatics, translational bioinformatics and clinical research informatics. Fusing different data streams such as clinical, imaging, molecular and other data modalities	**20%**	**9**
Unit 2 Working familiarity with SPSS and SAS. Basic methods for data import, data management, simple graphics, and basic statistical analysis are introduced.	**20%**	**9**

Unit 3: Clinical data: application of linear based models, search algorithms, ANNs, SVMs to case study data. Databases of medical informatics: VISTA, OPEN EMR, OPEN EHR Clinical Data and Systems, will explain the basics of Electronic Health Records, and how they operate in health care settings	**20%**	**9**
Unit 4: Image Data Health Science, will focus on an introduction to the main imaging modalities in medicine and how methodological analysis using machine vision can be used on large studies. Ethics, patient confidentiality and data protection Sources of medical data, Data protection act	**20%**	**9**
Unit 5: Introduction to the concept of medical decision making under uncertainty through an examination of disease probabilities and how they are altered by the characteristics of the diagnostic test being studies or used clinically. Decision trees will be introduced as a mechanism for communicating complex medical decisions and introductory level decision analysis will be presented. The measurement of patient values for alternative outcomes will be introduced as they pertain to direct payoff values as well as modifiers to cost payoffs	**20%**	**9**

Evaluation Scheme		**Total Marks 100**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	10 marks
	Skill enhancement activities / case study	15marks
	Presentation/ miscellaneous activities	10marks

Course Outcomes	Using computer-based case studies for developing information searching skills and implementing evidence-based medicine in patient care plans.
	Acquired breadth of knowledge of the principles of health informatics.
	Developed basic skills in using health informatics principles to improve practice.
	Acquired a conceptual and theoretical framework of the design, development, and implementation of health information systems
Additional Information to enhance learning	Expert talk required on specific topics.

Learning Resources	
1.	**Textbook & Reference Book** 1. Legal and Ethical Aspects of Health Information Management Dana C. McWay. 2. Introduction To Health Care Management Sharon Buchbinder. 3. Telehealth Security: An Examination of Variance in Telehealth Security Breaches Dr. Seria D. Lakes DSc.
2.	**Journals & Periodicals** 1. International Journal of Medical Informatics 2. Computer Methods and Programs in Biomedicine 3. Computers in Biology and Medicine
3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI216	COURSE NAME MICROBIAL INFORMATICS	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	30	2	0	0	2

Course Prerequisites	Basic Knowledge of Microbial Bioinformatics
Course Category	Elective
Course focus	Scientific Temperament & Employability
Rationale	Know how to develop your skills in Python Retrieve and analyze the biological data
Course Revision/ Approval Date:	06-03-2024
Course Objectives (As per Blooms' Taxonomy)	• Gain exposure to approaches for studying the function, structure and evolutionary history of genes observed in sequence datasets. Learn approaches for organizing sequence datasets into organismal units using marker genes (e.g., 16S) and shotgun metagenomics data. • Learn ecological statistical approaches to discern community structure and ecological drivers from large-scale metagenomic datasets. • Introduction to other sequence-based datasets including viral metagenomes, as well as metatranscriptomics, metaproteomics, metabolomics, etc. • Design, implement and interpret an informatics group project to further biological understanding of microbes

Course Content (Theory) Microbial	Weigh tage	Conta ct hour s
Unit 1 Diversity of Microorganisms, Microbial habitats, Metagenomics, Microbe-microbe interactions, Microbe-host interactions, Microbial communities- Biofilms, Quorum sensing, Bioremediation	**20%**	**6**
Unit 2 Microbial Identification and Characterization Bacterial genome characterisation and dynamics- Sequence alignments to Phylogenetic relationships- Prediction of Genes in prokaryotic genomes- Prediction of Operons, Regulons, transcription signals and biological pathways- Detection of Viruses using NGS – Reverse vaccinology: from genome to vaccine, Microbial genomics for antibiotic target discovery	**20%**	**6**

Unit 3 Microbial Genome Sequencing and Characterization Genome sequence analysis- Sequence assembly, Annotation of genomes from sequence to functional annotation, Atlas visualisation of genome-wide information - Comparative genomics and metagenomics- Genome-wide gene expression analyses- Representational display analysis of genome comparisons - Whole genome phylogenetic analysis	**20%**	**6**
Unit 4: Whole Metagenome profiling 16S rRNA microbiome – study design - Sample collection, extraction and library prep - 16S rRNA bioinformatics pipelines- Reads quality and processing - Normalization- - Hierarchical clustering- Taxonomic classification and profiling of bacterial communities – Downstream analysis in R - phyloseq, NMF, vegan, metagenomeSeq, micropan: an R-package for microbial pangenomics	**20%**	**6**
Unit 5: Metagenome and its application Metagenome sequencing: Cloning the metagenome, Preprocessing of raw sequence data, Downstream sequence analysis – community analysis in R, Shotgun sequencing – Sequencing errors and Diversity estimates, Functional and Pathway annotation- MetaCyc, BioCyc and KEGG, Genomic approaches to study Human microbiome – CRISPR-CAS9/TN-seq	**20%**	**6**

Learning Resources

1.	**Textbook & Reference Book** 1. Microbial Genomics and Bioinformatics" by Surajit Das and Hirak Ranjan Dash 2. Bioinformatics for Microbiologists: An Introduction" by Teresa K. Attwood, Stephen Pettifer, and David Thorne
2.	**Journals & Periodicals**
3	**Other Electronic resources**:

Evaluation Scheme		**Total Marks 100**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	10 marks
	Quiz	10marks
	Skill enhancement activities / case study	15marks
	Presentation/ miscellaneous activities	10marks

Course Outcomes	To Gain exposure to approaches for studying the function, structure and evolutionary history of genes observed in sequence datasets.
	To Learn ecological statistical approaches to discern community structure and ecological drivers from large-scale metagenomic datasets
	Understand Introduction to other sequence-based datasets including viral metagenomes, as well as metatranscriptomics, metaproteomics, metabolomics, etc.
	To Design, implement and interpret an informatics group project to further biological understanding of microbes
Additional Information to enhance learning	Expert talk required on specific topics.

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3

CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI311	COURSE NAME PROJECT PROPOSAL PREPARATION	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**

3	1	0	75	3	1	0	4

Course Pre-requisites	Basics of project proposal preparation
Course Category	Compulsory
Course focus	Scientific Temperament & Employability
Rationale	Allows students to apply theoretical knowledge to practical research, fostering critical thinking, problem-solving skills, and specialized expertise in their field of study.
Course Revision/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	1 To help students organize ideas, material and objectives for their d 2 The purpose of this course is to prepare the students to present the importance to their fellow classmates and teachers. 3 To understand how the papers are refereed 4 To know how papers published 5 To learn skills required for power point and poster presentations.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven.	**20%**	**06**
Unit 2: Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources.	**20%**	**06**
Unit 3: Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions,goals, approach, methodology, data collection, etc. Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation	**20%**	**06**
Unit 4: Poster Presentation: Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic	**20%**	**06**

Unit 5: Oral Presentation: At the end of their project, a presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.	**20%**	**06**

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works,Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
Afer successful completion of the above course, students will be able to:	Understand, Remember& apply	Explain, Describe, Discuss, Recall, Locate
CO1 Formulate a scientific question		
CO2 Present scientific approach to solve the problem	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 Interpret, discuss and communicate scientific results in written form	Evaoluate	Compare, Classify, Select, Investigate
CO4 Gain experience in writing a scientific proposaldiagnostics strategy.	Apply	Construct, Develop, Produce
CO5 Learn how to present and explain their research findings to the audience effectively	Understand, Remember& apply	Explain, Describe, outline, Predict, Summarize

Learning Resources

1	Textbook 1. Nicholas Rowe (2017) Academic & Scientific Poster Presentation : A Modern Comprehensive Guide 2. Kelly Coleman,Kathleen Petelinsek (2014) Choose It! Finding the Right Research Topic 3. Ralph Berry (2000) The Research Project: How to write it 4. Alexei Kapterev (2011) Presentation secrets, Do What You Never Thought Possible with Your Presentations, John Wiley & Sons 5. Writing Scientific Research Articles (2nd Edition) By Margaret Cargill, Patrick O'Connor (2013) 6. Scientific Writing: Easy When You Know How By Jennifer Peat, Elizabeth Elliott, Louise Baur, Victoria Keena (2013) 7. How to Write a Paper (5th Edition) Edited by George M. Hall (2012) 8. How to Write a Great Research Paper By Book Builders, Beverly Chin, (2004) 9. Research Papers for Dummies By Geraldine Woods (2002) 10. Nicholas Rowe (2017) Academic & Scientific Poster Presentation : A Modern Comprehensive Guide 11. Kelly Coleman,Kathleen Petelinsek (2014) Choose It! Finding the Right Research Topic 12. Ralph Berry (2000) The Research Project: How to write it 13. Alexei Kapterev (2011) Presentation secrets, Do What You Never Thought Possible with Your Presentations, John Wiley & Sons 14. Writing Scientific Research Articles (2nd Edition) By Margaret Cargill, Patrick O'Connor (2013) 15. Scientific Writing: Easy When You Know How By Jennifer Peat, Elizabeth Elliott, Louise Baur, Victoria Keena (2013) 16. How to Write a Paper (5th Edition) Edited by George M. Hall (2012) 17. How to Write a Great Research Paper By Book Builders, Beverly Chin, (2004) 18. Research Papers for Dummies By Geraldine Woods (2002)

2	Other Electronic resources 1. Springer® Journal author tutorials now with interactive courses: Free online course and tutorial. 2. Elsevier® Researcher Academy Researcher Academy provides free access to countless e-learning resources designed to support researchers on every step of their research journey. 3. Wiley Author Webinars 4. Writing Scientific Papers Scitable by Nature Education 5. How to Write a World Class Paper From title to references From submission to revision 6. Duke Graduate School Scientific Writing Resource 7. Writing scientific papers: 8 Improving the English 8. How to write a Great Research Paper, and Get it Accepted by a Good Journal. 9. How to Publish Without Perishing: Finding the Time to Write 10. Article Introductions: More Important Than You Thought! 11. 5 Tips for Writing Better Science Papers 12. What Makes a Good Abstract? 13. Biotechnology news 14. Science Daily 15. Nature News 16. Science News 17. Retraction watch (Information about Scientific Misconduct) 18. COPE: Publishing ethics (Website contains information about publication ethics and practical resources)

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Open Book Assignment: 15 marks Article Review: 10 marks **Total: 40 Marks**
ractical Marks	Attendance: 05 marks Practical Exam: 20 marks Viva: 10 marks

		Journal	10 marks
		Discipline	05 marks
		Total	**50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	2	-	2	-	-	1
CO2	-	2	2	-	1	-
CO3	2	-	-	-	2	-
CO4	1	-	-	3	-	-
CO5	-	-	-	2	-	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI312	COURSE NAME EMERGING TECHNOLOGIES	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	1	0	75	3	1	0	4

Course Prerequisites	Students should have knowledge about emerging technologies
Course Category	Compulsory
Course focus	Scientific Temperament & Employability
Rationale	Broad-based in nature encompassing several new technologies those current experimental researchers are employing to probe complex system biology questions in life-sciences.
Course Revision/ Approval Date:	06/03/2024
Course Objectives **(As per Blooms' Taxonomy)**	1 This course is broad-based in nature encompassing several new technologiesthat current experimental researchers are employing to probe complex system biology questions in life-sciences. 2 The objectives of this course are to teach basics of the new principles to studentsso as to appreciate current-day research tool-kit better. 3 Understanding the need for Technologies 4 Understanding the advanced technologies 5 Applications of Emerging Technologies

Course Content (Theory)	Weightage	Contact hours
Unit 1: **Optical microscopy methods** **Basic Microscopy:**Light Microscopy: Phase Contrast and Bright field. Fluorescence and fluorescence microscopy: what is fluorescence, what makes a molecule fluorescent,fluorescence microscope **Advanced Microscopy:** Confocal microscope: scanningoptical microscope, Confocal principle, resolution and point spreadfunction. **Nonlinear microscopy:** Multiphoton microscopy; principles of two-photonfluorescence. **Advanced fluorescence technique** FRET and FCS	**20%**	**9**
Unit 2: **Mass spectroscopy** Ionization techniques; mass analyzers/overview MS; fragmentation of peptides;proteomics, nano LC-MS; Phospho proteomics; interaction proteomics,mass spectroscopy in structural biology; imaging mass spectrometry.	**20%**	**9**
Unit 3: Systems biology High throughput screens in cellular Systems, target identification,validation of experimental methods togenerate the omics data. **Structural biology** X-ray diffraction methods,Solution & solid-state NMR, Cryo electronmicroscopy, Atomic force microscopy.	**20%**	**9**
Unit 4: **CRISPR-CAS** History of its discovery, mechanism including introduction to all the molecular players. Development of applications for in vivo genome engineering forgenetic studies, Promise of the technology as a next generation therapeutic method.	**20%**	**9**
Unit 5: **NANOBODIES** Introduction to nanobodies, phage display method for development of antibody against native proteins,nanobody as a tool for protein structure function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.	**20%**	**9**

List of Practicals
Hand on use of ELISA
Demonstration of GC
Demonstration of HPLC
Hands on use of fluorescent microscope
Demonstration of AAS
Demonstration of RT-PCR

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain

After successful completion of the above course, students will be able to: **CO1** This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences. **CO2** The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better. **CO3**Understanding the need for Technologies **CO4** Understanding the advanced technologies. **CO5** Applications of Emerging Technologies	Remember Apply Analyses and Evaluation Create Understand	Explain, Describe, Discuss, Recall, Locate Apply, Practice, Interpret, Select, Correlate Compare, Classify, Select, Investigate Construct, Develop, Produce Explain, Describe, outline, Predict, Summarise
Learning Resources		

1.	**Textbook & Reference Books** 1. Campbell, I.D. (2012). Biophysical Techniques. Oxford: Oxford University Press. 2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press. 3. Phillips, R., Kondev, J., & Theriot, J.(2009). Physical Biology of the Cell. New York: Garland Science. 4. Nelson, P.C., Radosavljević, M.,&Bromberg, S.(2004). Biological Physics: Energy, Information, Life. New York: W.H.Freeman. 5. Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1),993-1016.doi:10.1146/annurev. biochem.77.061906.092014. 6. Mohanraju, P.,Makarova, K. S., Zetsche, B., Zhang, F.,Koonin, E. V.,& Oost, J. V. (2016).Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems. Science, 353(6299). doi:10.1126/science.aad5147. 7. Lander, E.(2016).The Heroes of CRISPR. Cell, 164(1-2), 18-28.doi:10.1016/j. cell.2015.12.041. 8.Ledford, H.(2016).TheUnsungHeroesofCRISPR.Nature,535(7612),342-344. doi:10.1038/535342a. 9. Jinek,M., Chylinski, K., Fonfara,I., Hauer,M.,Doudna,J.A., &Charpentier,E. (2012). A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity. Science, 337(6096), 816-821.doi:10.1126/science.1225829. 10. Hamers-Casterman,C.,Atarhouch,T.,Muyldermans,S.,Robinson,G.,Hammers, C., Songa, E. B., Hammers, R. (1993). Naturally Occurring Antibodies Devoid of Light Chains. Nature, 363(6428), 446-448.doi:10.1038/363446a0. 11. Sidhu, S. S., & Koide, S. (2007). Phage Display for Engineering and Analysing Protein Interaction Interfaces. Current Opinion in Structural Biology, 17(4), 481-487. doi:10.1016/j.sbi.2007.08.007. 12. Steyaert, J., & Kobilka, B. K.(2011). Nanobody Stabilization of G Protein-Coupled Receptor Conformational States. Current Opinionin Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011. 13. Vincke, C., & Muyldermans, S. (2012). Introduction to Heavy Chain Antibodies and Derived Nanobodies. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779- 968-6_2. 14. Verheesen, P.,& Laeremans, T.(2012). Selection by Phage Display of Single Domain Antibodies Specific to Antigens in their Native Conformation. Single Domain Antibodies, 81-104.doi:10.1007/978-1-61779-968-6_6. 15. Li,J.,Xia,L.,Su,Y.,Liu,H.,Xia,X.,Lu,Q.Reheman,K.(2012).Molecular Imprint of Enzyme Active Site by Camel Nanobodies. Journal of Biological Chemistry J. Biol. Chem., 287(17), 13713-13721.doi:10.1074/jbc.m111.336370. 16.Sohier,J.,Laurent,C.,Chevigné,A.,Pardon,E.,Srinivasan,V.,Wernery,U.Galleni, M. (2013). Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody. Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305. 17. Chakravarty, R., Goel, S., & Cai, W.(2014). Nanobody: The "Magic Bullet" for Molecular Imaging?Theranostics,4(4),386-398.doi:10.7150/thno.8006.
2.	Journals & Periodicals 1. JBC, 2. Science, 3. Plos biology 4. Periodicals: current science

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
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<tr><td>Skill enhancement activities / case study</td><td>15 marks</td></tr>
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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI313	COURSE NAME AI AND BIOINFORMATICS	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	1	0	75	3	1	0	4

Course Pre-requisites	Students should have knowledge of AI in bioinformatics
Course Category	Specialization
Rationale	Scientific Temperament & Employability
Course Revision/ Approval Date:	6/03/2024
Course Objectives (As per Blooms' Taxonomy)	The course aims to equip students with the skills to apply AI techniques to analyze and interpret biological data, solve complex bioinformatics problems, and understand the ethical implications of AI in biological research.

Course Content (Theory)	Weightage	Contact hours
Unit 1: AI, machine learning, deep learning, and natural language processing (NPL).	**20%**	**10**
Unit 2: Collecting, analysing, and modeling bioinformatics data using AI.	**20%**	**10**
Unit 3: AI-based bioinformatics research, including genome sequencing, protein function prediction, and gene expression examination.	**20%**	**10**
Unit 4: AI toolkit for working in bioinformatics	**20%**	**10**
Unit 5: Case studies: wrt Cardiovascular diseases, Nervous system disorder, Neonatal disorders.	**20%**	**05**

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to:	Understand, Remember & apply	Explain, Describe, Discuss, Recall, Locate
• Apply machine learning and deep learning techniques to analyze genomic, proteomic, and other biological data.	Apply	Apply, Practice, Interpret,
• Develop AI-driven solutions for bioinformatics challenges such as sequence alignment, gene prediction, and protein structure prediction.	Evaluate	Select, Correlate Compare,
• Implement data preprocessing, feature extraction, and model evaluation strategies specific to bioinformatics data.	Apply	Classify, Select, Investigate
• Utilize bioinformatics software tools and programming languages like Python and R for AI applications.	Understand, Remember & apply	Construct, Develop, Produce
• Interpret and visualize the results of AI models in the context of biological research.		Explain,
• Understand the ethical considerations and limitations		Describe,

of using AI in bioinformatics. • Conduct independent research or contribute to collaborative projects involving AI in bioinformatics.		outline, Predict, Summarize

Learning Resources	
1	Textbook • Bioinformatics and Computational Biology Solutions Using R and Bioconductor"** by Robert Gentleman, Vincent Carey, Wolfgang Huber, Rafael Irizarry, and Sandrine Dudoit. • Artificial Intelligence and Machine Learning for Business: A No-Nonsense Guide to Data Driven Technologies"by Steven Finlay. • Deep Learning for the Life Sciences: Applying Deep Learning to Genomics, Microscopy, Drug Discovery, and More" by Bharath Ramsundar, Peter Eastman, Patrick Walters, and Vijay Pande. • Machine Learning for Bioinformatics by Pierre Baldi and Søren Brunak. • Bioinformatics Algorithms: An Active Learning Approach"** by Phillip Compeau and Pavel Pevzner. • Introduction to Bioinformatics by Arthur Lesk.
2	Reference book :
3	Journal : Journal of Bioinformatics and Computational Biology BMC Bioinformatics
5	Periodicals:
6	Other Electronic resources: NPTL and UGC Pathshala lectures

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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI314	COURSE NAME INTRODUCTION TO SYSTEMS BIOLOGY	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	1	0	75	3	1	0	4

Course Prerequisites	Basics of systems biology
Course Category	Specialization
Course focus	Scientific Temperament & Employability
Rationale	Understanding the larger of biology at the level of the organism, tissue, or cell by putting its pieces together
Course Revision/ Approval Date:	06-03-2024
Course Objectives (As per Blooms' Taxonomy)	• To understand how genomics applications are used to unravel the biology of life and the basic principles of systems biology. • To provide the basis for gaining insight in bioinformatics and computational genomic

Course Content	Weightage	Contact hours
Unit 1: Introduction to cellular and population-level systems biology with an emphasis on synthetic biology, modeling of genetic networks, cell-cell interactions and evolutionary dynamics	**20%**	**6**
Unit 2: Cellular level systems: genetic switches and oscillators, network motifs, genetic network evolution, and cellular decision-making Concepts of genotypes and phenotypes, genotype networks and fitness landscapes	**20%**	**6**
Unit 3: Population-level systems: models of pattern formation, cell-cell communication, and evolutionary systems	**20%**	**6**
Unit 4: Gene regulation networks: - Negative and positive regulation in transcription networks, - Feed-forward loops, Oscillatory circuits, Optimality and robustness. Robustness in biological systems, Principles of optimality	**20%**	**6**

Unit 5: Stochasticity in biological processes data analysis investigating stochasticity, Metabolic networks ad flux analysis. Metabolic engineering, Introduction to synthetic biology.	**20%**	**6**

Learning Resources	
1.	**Textbook & Reference Book** 1) Giacovazzo, C. (2013). Phasing in crystallography: a modern perspective. Rendiconti Lincei, 24(1), 71- 76. 2) Hargittai, I. (2009). Christopher Hammond: The basics of crystallography and diffraction. 3) Ladd, M. F. C., Palmer, R. A., & Palmer, R. A. (2003). Structure determination by X-ray crystallography (p. 71). New York: Plenum Press. 4) Monaco, H. L., Artioli, G., Viterbo, D., Ferraris, G., & Giacovazzo, C. (2011). Fundamentals of crystallography (Vol. 7). C. Giacovazzo (3rd ed.). Oxford: Oxford University Press. 5) Paufler, P., Stout, G. H., & Jensen, L. H. (1991). Xray structure determination. John Wiley & Sons, ISBN 0–471– 60711–8. 6) Crystal Research and Technology, 26(8), 1070-1070. Rhodes, G. (2010). Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier
2.	**Journals & Periodicals** 8. Frontiers in Systems Biology 9. npj Systems Biology and Applications 10. Current Opinion in Systems Biology
3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Course Outcomes	Describe the development of Omics technologies, with emphasis on genomics and proteomics.
	To use bioinformatics techniques to query examples of genomic and proteomic databases to analyze cell biology
	Understand the principles of integrative analysis methods for biological system analysis and interactions
Additional Information to enhance learning	Expert talk required on specific topics.

Evaluation Scheme		**Total Marks 100**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	10 marks
	Skill enhancement activities / case study	10 marks
	Presentation/ miscellaneous activities	15 marks

Mapping of PSOs and COs

PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI315	COURSE NAME IMMUNOINFORMATICS	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
2	0	0	30	2	0	0	2

Course Prerequisites	Basic Knowledge of computers
Course Category	Elective
Course focus	Scientific Temperament & Employability
Rationale	Know how to develop your skills in Bioinformatics. Retrieve and analyze the biological data
Course Revision/ Approval Date:	06-03-2024
Course Objectives (As per Blooms' Taxonomy)	• **To Remember** the basic concepts of immunology • **Understand** the concepts of informatics in immunology • **To analyze and evaluate** immunological data using infromatics • **Apply** the knowledge of informatics to analyse the biological data • **To Create** stand-alone programs to process biological data

Course content	Weightage	Contact hours
Unit 1 Immune system and its types Innate and Adaptive Immunity: Cell types and processes involved, Anatomical and Physiological Barriers, Inflammation, Soluble molecules and Toll-like receptors, Innate Immune response and their recognition structures, Humoral and Cell mediated responses of immune system. Cells of Immune system: Lymphocytes, Mononuclear phagocytes, Antigen Presenting cells, polymorphs, Natural Killer cells, Granulocytes, Mast cells, Dendritic cells, Cluster designation (CD) and antigen specific receptors. Organs of Immune system: Primary lymphoid organs (Bone marrow and Thymus). Secondary Lymphoid organs (Lymph node, spleen and MALT).	**20%**	**6**
Unit 2 Immunoglobulins Immunoglobulins: Structure and function - Clonal selection theory – Ig Classes and subclasses, DR and LDR regions and sequence numbering, Immunogenetics & Immunogenomics, Monoclonal antibodies: Hybridoma technology, applications, Humanization of antibodies by design. Membrane receptors for antigen- B-cell generation and differentiation - T-dependent activation of B cells - Recognition of Antigen by B cells, Neutralizing Antibody. Cytokines: Cytokine receptors and signal transduction mediated by class I and II cytokine receptors. Complement system- activation, pathways and biological effects		
Unit 3 Databases & tools: IMGT & IEDB, BciPep, Epitome, CED, Ag-Ab database, Allergen Databases, Allergenicity Prediction. Major Histocompatibility Complex: Structure and functions of MHC class I and II, MHC polymorphism, MHC supertypes, MHC peptides Specificity, characterization, MHCpeptide designing tool. HLA: nomenclature, HLA-peptide interactions, Antigen Processing in the MHC Class I Pathway, Processing of MHC Class II Epitopes, Sequential and Conformational Epitopes, Epitope Prediction algorithms - T cell, B cell epitope prediction tool.	**20%**	**6**
Unit 4: Vaccine Design and Development Rational vaccine design, Reverse vaccinology, Prediction of immunogenicity - Pipeline & workflows, Toxoid as vaccine, Conjugate vaccine, DNA vaccine, Recombinant vector vaccines, Personalised vaccination. Structure-based Vaccine design - tools and techniques, Antigenicity modification, Epitope replacement, germline targeting, Epitope focussing, hyperglycosylation, chimeric fusion, epitope scaffold, Conformational stabilization, multimeric scaffolding, stabilizing mutations, Antigen display and delivery platforms - multivalent display, co-display, immunomodulation, Genetic delivery**.**	**20%**	**6**

Unit 5: Immunoinformatics in Health and Diseases Cancer Immunology: Malignant transformation of cells, Oncogenes and cancer induction, Tumors of immune system, Tumor antigens, Tumor evasion of the immune system, Cancer immunotherapy. Secondary immunodeficiency in AIDS: Mode of infection, causative agent, HIV infection of target cells and activation of Provirus, Immunological abnormalities associated with HIV infection, Discrete Models of HIV Infection, Simulation of HIV-1 Infection. Emerging and Re-emerging Infectious Diseases – Pathogens with antigenic variation, Modifying and Improving Biological Therapeutics, Computational Immunology.	**20%**	**6**

Course Outcomes	Students can understand the structure and function at the molecular and cellular level of the immune defense.
	Students will be able to describe immunological response and how it is triggered and regulated
	Apply informatics to analyze immunological data
Additional Information to enhance learning	Expert talk required on specific topics.

Evaluation Scheme		**Total Marks 100**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	10 marks
	Skill enhancement activities / case study	10 marks
	Presentation/ miscellaneous activities	15 marks

Learning Resources	
1	**Journals & Periodicals** 11. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2017). Cellular and molecular immunology E-book. Elsevier Health Sciences. 12. Annadurai, B., (2017). A Textbook of Immunology &Immunotechnology. S Chand & Company. 13. Kannan, I. (2013). Immunology: MJP Publication. 14. Levinson, W. E. (2016). Review of Medical Microbiology and Immunology 14E. McGraw Hill 15. Professional.Vaman Rao., (2016). Immunology. New Delhi: Narosa Publishing House Pvt, Ltd.
2	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-

CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBI316	COURSE NAME AGRIINFORMATICS	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
2	0	0	2	2	0	0	2

Course Pre-requisites	Students should have knowledge of agriinformatics
Course Category	**Elective**
Course focus	Elective
Rationale	Scientific Temperament & Employability
Course Revision/ Approval Date:	6/03/2024
Course Objectives (As per Blooms' Taxonomy)	Agriinformatics integrates technology and data analysis to enhance agricultural productivity, sustainability, and decision-making.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Use of ICT in Agriculture. Computer models for understanding plant processes.	**20%**	**10**
Unit 2: IT application for computation of water and nutrient requirement of crops. Computer-controlled devices (automated systems) for Agri-input management. .	**20%**	**10**
Unit 3: Smartphone Apps in agriculture for farm advises, market price and postharvest management.	**20%**	**10**
Unit 4: Geospatial technology for generating valuable agri-information.	**20%**	**10**
Unit 5: Decision support systems, preparation of contingent crop-planning using IT tools.	**20%**	**10**

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	**Blooms' Taxonomy**	**Blooms' Taxonomy Sub**
	Domain	**Domain**
After successful completion of the above course, students will be able to:	Understand, Remember & apply	Explain, Describe, Discuss, Recall, Locate
• Apply data analysis and informatics tools to optimize agricultural practices and improve crop yields.	Apply	Apply, Practice, Interpret, Select, Correlate Compare,
• Utilize GIS and remote sensing technologies for precision farming and resource management.	Evaluate	Classify, Select, Investigate Construct, Develop, Produce
• Analyze and interpret agricultural data to make informed decisions for sustainable farming.		
• Develop and implement digital solutions to address challenges in agriculture, such as pest control, irrigation, and soil management.	Apply	Explain, Describe, outline, Predict, Summarize
	Understand,	

	Remember & apply	

Learning Resources	
1	Textbook 1) Computer Fundamentals by Pradeep K. Sinha and Priti Sinha, III edition, BPB Publications, B-14, Connaught Place, New Delhi – 110 001. 2) Computer Fundamentals by P.K. Sinha, BPB Publications, B-14, Connaught Place, New Delhi – 110 001. 3) Mastering Office Professional for window 95, BPB Publications, B-14, Connaught Place, New Delhi – 110 001. 4) Statistical Methods for Agricultural workers by V.G. Panse and P.V. Sukhatma, ICAR, New Delhi.
2	Reference book :
3	Journal : Journal of Medicinal Chemistry
5	Periodicals:
6	Other Electronic resources: NPTL and UGC Pathshala lectures

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CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None