M.Sc. (BIOINFORMATICS)
COURSE CURRICULUM

(w.e.f. Session 2024-25)

INSTITUTE OF APPLIED SCIENCES & HUMANITIES

AMENDMENTS AS RECOMMENDED BY BOARD OF STUDIES 2024-25

(Date: .....)

COURSE STRUCTURE
M.Sc. (BIOINFORMATICS)

First Semester

S. NO.	CODE	SUBJECT	CORE/ELECTIVES	TEACHING SCHEME			CREDITS	CONTACT HR/WK
				L	T	P		
1		Advanced Biostatistics	Open Elective	3	1	0	4	4
2.		Biochemistry	Core	4	0	0	4	4
3.		Cell and Molecular Biology	Core	4	0	0	4	4
4.		Fundamentals of Bioinformatics	Core	4	0	0	4	4
5.		Biophysical Techniques	Core	4	0	0	4	4
PRACTICALS								
6.		Biostatistics Lab	Core	0	0	3	2	3
7.		Fundamentals of Bioinformatics Lab	Core	0	0	3	2	3
8.		Biochemistry & Biophysical Techniques &Lab	Core	0	0	3	2	3
Total				**19**	**1**	**9**	**26**	**29**

Second Semester

S. NO.	CODE	SUBJECT	CORE/ELECTIVES	TEACHING SCHEME			CREDITS	CONTACT HR/WK
				L	T	P		
1.		Biothermodynamics	Core	4	0	0	4	4
2		Molecular Modelling and Drug Design	Core	4	0	0	4	4
3.		Sequence analysis	Core	4	0	0	4	4
4.		Programming in Python	Core	4	0	0	4	4
5.		Cheminformatics	Open Electives	4	0	0	4	4
6		Soft skills I	Humanities	1	0	0	1	1
PRACTICALS								
7.		Programming in Python Lab	Core	0	0	3	2	3
8.		Molecular Modelling and Drug Design	Core	0	0	3	2	3
9.		Sequence analysis lab	Core	0	0	3	2	3
Total				**21**	**0**	**9**	**27**	**30**

Third Semester

S. No.	CODE	SUBJECT	CORE /ELECTIVES	TEACHING SCHEME			CREDITS	cONTACT hR/WK
				L	T	P		
1.		Data mining and big data analysis	Core	4	0	0	4	4
2.		Genomics and Proteomics	Core	4	0	0	4	4
3.		R language	Core	4	0	0	4	4
4.		System & Structural Biology	Core	4	0	0	4	4
5		Soft skill II	Humanities	1	0	0	1	1
ELECTIVES (Select any two)								
6.		Nanobiotechnology	Elective	2	0	0	2	2
7.		Artificial Intelligence in Bioinformatics	Elective	2	0	0	2	2
8.		Clinical Research in Medicinal Plants	Elective	2	0	0	2	2
9.		Bioinformatics applications to Protein Structure	Elective	2	0	0	2	2
10.								
ELECTIVES (Select any one)								
11.		Research Methodology	Elective	2	0	0	2	2
12.		IPR, Patent, Trademarks & Bioethics	Elective	2	0	0	2	2
		Immuno-informatics	Elective	2	0	0	2	2
PRACTICALS								
13.		Genomics & Proteomics Lab	Core	3	0	3	2	3
14.		R language Lab	Core	3	0	3	2	3
PRACTICALS BASED ON ELECTIVES (Select any two)								
15.		Artificial Intelligence in Bioinformatics Lab	Elective	2	0	2	1	2
16.		Nanobiotechnology Lab	Elective	2	0	2	1	2
17.		Clinical Research in Medicinal Plants Lab	Elective	2	0	2	1	2
18.		Bioinformatics applications to Protein Structure Lab	Elective	2	0	2	1	2
Total				**33**	**0**	**10**	**29**	**33**

Fourth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACT HR/WK
			L	T	P		
1.		Project Work	-	-	-	16	-
Total			**0**	**0**	**0**	**16**	**-**

S. No.	Category	Subject	Credit	Total Credits
1	Core (Theory)	12	4	48
2	Core (Practical)	8	2	16
3	Electives (Theory)	3	2	6
4	Electives (Practical)	2	1	2
5	Open Elective (Theory)	2	4	8
6	Humanities	2	1	2
7	Project	1	16	16
	Total Credits			98

SYLLABUS
M.Sc.
(BIOINFORMATICS)

MMAS 0501: ADVANCED BIOSTATISTICS

OBJECTIVES: To make the students understand the advanced concepts of biostatistics,

Credits: 04 **Semester** **L–T–P: 3–1–0**

Module No.	Content	Teaching Hours
I	**Numerical descriptive techniques**: Measures of central tendency-mean, median, mode, Partition values-quartiles, deciles, percentiles, Measure of dispersion, Moments, Skewness, Kurtosis. **Correlation and Regression**: Principle of least squares, scatter diagram, correlation, covariance, correlation coefficient, properties of correlation coefficient, regression, properties of linear regression, rank correlation, multiple correlation. **Probability Theory**: Classical and modern definition of probability, Sample space and events, independent events, mutually exclusive events, axioms of probability, conditional probability, additional and multiplication theorem of probability, Baye's theorem.	18
II	**Sampling Theory:** Objective of sampling, Sampling error, Methods of sampling, Sampling distribution, Sampling distribution of sample mean and sample proportion, Standard error. **Probability Distribution:** Bernoulli's trial, Binomial distribution, Poisson distribution, Poisson approximation to Binomial distribution, Normal and Standard normal distribution, Normal approximation to Binomial (Poisson), Student's t distribution, Chi-square distribution, F-distribution, algebra and differential equations.	24

Text Books:

1.P. Banerjee, Introduction to Biostatistics, S. Chand & Co., Delhi, 2006.
2.G. C. Beri, Business Statistics, TMH, New Delhi, 2015.
3.H. Kishan, Differential Equations, Atlantic Publishers and Distributors, Delhi, 2008.

Reference Books:

1.S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Delhi, 2014.
2.B. K. Mahajan, Methods in Biostatistics, Jaypee Brothers Pub., New Delhi, 2010.

COURSE OUTCOMES: By the end of this course, the students will be able:

C01: Understand the concepts of vector algebra and matrix algebra. ***(Remembering, Understand, and Apply `)***

C02: Able to formulate ordinary differential equations and obtain their solutions. . ***(Remembering, Understand, Create and Analyze)***

C03: Able to understand the concepts of biostatistics and to be able to recognize different type of data arising in public health & clinical studies. ***(Remembering, Understand, Apply, Analyze and Create`)***

C04: Understand how to know the behavior and structure of data with the help of moments. . ***(Remembering and Understand`)***

C05: Able to fit different models (urnes) on real life data. ***(Remembering, Understand, Apply, and Analyze`)***

C06: Understand the concepts of statistical inference (resting). . ***(Remembering and Understand`)***

C07: Understand what is Anova and how to apply it in real- life situations. . ***(Remembering, Understand, Apply and Analyze`)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO2, PO3, PO5, PO8/PSO1, PSO2
CO2	PO1, PO2, PO4/PSO1
CO3	PO1, PO6, PO7,PO8/PSO2
CO4	
CO5	
CO6	
CO7	

MSBC 0001: BIOCHEMISTRY

OBJECTIVES: The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of lecture series.

Credits: 04 **Semester I** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	*Carbohydrates* **Glycolysis**: definition, location, reactions, stoichiometry, fate of pyruvate, ATP production, energetics of Glycolysis, regulation **Kreb's cycle:** definition, location, pyruvate dehydrogenase enzyme complex, reactions, stoichiometry, amphibolic nature, energetics of TCA cycle, regulatio, Mitochondrial electron transport and oxidative phosphorylation. Anaerobic respiration in bacteria. **Alternative pathways of Carbohydrate metabolism:** pentose phosphate pathway (function, location, reactions, stoichiometry, regulation), uronic acid pathway, metabolism of fructose, metabolism of lactose, metabolism of amino sugars *Amino acids* **Biosynthesis of amino acids:** biosynthesis of alanine, aspartate, asparagine, glutamate, glutamine, arginine, proline, serine, glycine, cysteine, tyrosine, feed back regulation of amino acid biosynthesis. **Amino acid degradation:** transamination, oxidative deamination, conversion of alanine, serine and cysteine into pyruvate, conversion of aspartate and asparagines into oxaloacetate, conversion of glutamine, histidine, arginine, proline into α- ketoglutarate through glutamate, conversion of methionine, isoleucine, valine into succinyl-CoA, catabolism of phenylalanine, tyrosine and tryptophan	18
II	*Lipids* **Biosynthesis of fatty acids:** formation of malonyl CoA, fatty acid synthase complex, reactions of fatty acid synthase, elongation of fatty acid chains, regulation of fatty acid biosynthesis. **Fatty acid oxidation:** activation of fatty acids, role of carnitine in transport of long chain fatty acid, β oxidation of saturated and unsaturated fatty acids, oxidation of odd chain fatty acids, regulation of fatty acid oxidation *Nucleic acids* **Biosynthesis of Purine and Pyrimidine Nucleotide:** De novo synthesis of purine nucleotides, regulation of De novo synthesis of purine nucleotides, salvage pathway for purine nucleotides, De novo synthesis of pyrimidine nucleotides, regulation of pyrimidine synthesis, salvage pathway for pyrimidine nucleotides, formation of deoxyribonucleotides Degradation of Purine and Pyrimidine nucleotides. **Inborn errors of metabolism:**Protein- PKU, Alkaptonuria, Maple syrup &Gauchers disease Carbohydrates: glycogen storage disorders, Cori's disease & Pomes disease Lipids- Atherosclerosis. Nucleic acids- Gout, Lesch-Nyhan syndrome, Sickle cell anaemia	24

Text Book:

- J.L. Jain, S. Jain and N. Jain, "Fundamental of Biochemistry": S. Chand & Company Pvt. Ltd, 2016

Reference Books:

- J. M. Berg, L. Stryer, J. L Tymoczko and G.J. Gatto, "Biochemistry" : W.H. Freeman, 2015
- D.L. Nelson and M. Cox, "LehningerPrinciples of Biochemistry" : W.H. Freeman,
- D.J. Voet, J.G. Voet and C.W. Pratt, " Principles of Biochemistry" : John Wiley & Sons, Inc, 2012

COURSE OUTCOMES: The major outcomes of this course are:

CO1: Understand the degradative pathways (Glycolysis & TCA cycle) of carbohydrate metabolism. ***(Remembering, Understand)***
CO2: Understand the metabolism of fructose, lactose and amino sugars. ***(Remembering, Understand)***
CO3: Know various pathways for biosynthesis and degradation of amino acids. ***(Remembering, Analyze)***
CO4: Know various steps of Lipogenesis and its regulation. **(Remembering, *Understand, Analyze*)**
CO5: Understand different types of fatty acid oxidation, energy yields and its regulation. ***(Apply, Remembering, Analyze)***
CO6: Understand De-novo and Salvage pathway of nucleotide biosynthesis with regulation and to know about various steps of degradation of purine and pyrimidine nucleotides.
(Remembering, Understand, Apply, Analyze)
CO7: Know the carbohydrates, proteins, lipids and nucleic acid related inborn error of metabolism. ***(Understand, Remembering and Analyse)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO3, PO4, PO7/PSO1, PSO2
CO2	PO2, PO4, PO5, PO8/PSO1, PSO2
CO3	PO1, PO3, PO5, PO6, PO8/PSO1, PSO2
CO4	
CO5	
CO6	
CO7	

MSBC0002: CELL AND MOLECULAR BIOLOGY

OBJECTIVES:. The course designed for in-depth approach to biological topics. An introduction to the physical and chemical organization of living organisms; cell structure, function, and metabolism; classical and molecular genetics; gene regulation; genetic engineering; molecular aspects of development; and reproduction.

Credits: 04 **Semester I** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	• **Cell as a unit of living system**-Discovery of cell, development of cell theory, structure of Bacterial, plant and animal cell • **Cell membrane**- structure and function (Active, passive communication junction) • **Structure and function of different organelles** (Cytoskeleton, Endoplasmic reticulum, Golgi complex, Vesicles, Lysosomes. Nucleus, mitochondria and chloroplast), Endo-symbiotic theory • **DNA and Protein Synthesis** – Genomic DNA structural organization, Replication, Transcription, Translation and their post-modifications, Gene regulation in eukaryotic and prokaryotic cells.	18
II	• Synthesis of secretary & membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes • **Cell signaling:** exocrine, endocrine, paracrine and synaptic strategies of chemical signaling, surface receptor mediated transduction (DAG, Ca++. c-AMP , G-protein) • **Steps in cell cycle**, cell cycle check points, cell division control and regulation • **Apoptosis:** phases and significance, morphological and biochemical changes associated with apoptotic cell • Oncogenesis • Nucleic acids and protein sequencing	24

Text Book:

1.Cell Biology by Rastogi, Veer Bala

Reference Books:

1.Molecular Biology of the cell by Alberts, et al
2.Molecular Cell biology by Lodish, et al
3.Working with Molecular Cell Biology: A study companion by Stories et al
4.Cell and Molecular Biology: concepts and Experiments by Gerald Karp
5.The cell: A Molecular Approach by G.M.Cooper
6.The world of Cell by Becker et al
7.Cell proliferation and apoptosis by Hughes and Mehnet

8.Essential Cell Biology by Alberts et al
9.Cell biology, genetics, molecular biology, evolution and ecology by Verma and Agrawal
10.Cell and molecular biology, de Robertis&dfRoberties

COURSE OUTCOMES: The major outcomes of this course are:

CO-1: Understand the structure and function of various organelles and macromolecular components of cells and their functions. (***Understanding)***

CO-2: Familiarize with Cell Cycle and its regulatory check points and understand how cell grow, divide and die. (***Knowledge)***

CO-3: Know the structure and function of Biological membrane and mechanism of exchange of compounds across the plasma membrane. ***(Understanding)***

CO-4: Explain the morphology and physiological functions of ER, Ribosomes and protein targeting on ER. Understand Trans Golgi Network and protein secretion. ***(Analyze)***

CO-5: Able to explain basic pathways and mechanisms in biological energy transduction from oxidation of metabolites to synthesis of ATP. ***(Analyze)***

CO-6: Explain the different types of cellular signaling pathways. ***(Analyze)***

CO-7: Discuss the process of Carcinogenesis and apoptosis in detail. ***(Analyze)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1, PO3,PO4, PO5, PO7/PSO1, PSO2
CO2	
CO3	
CO4	
CO5	
CO6	
CO7	

MSBC 0003: FUNDAMENTALS OF BIOINFORMATICS

OBJECTIVES: To expose students with essential elements of bioinformatics, viz. structural bioinformatics, functional bioinformatics, database searching and scope of various biological databases in life science research.

Credits: 04 **Semester I** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction to Biological Databases Types** of Biological data- nucleotide sequence databases-GenBank, EMBL, DDBJ; protein sequence database- SWISS-PROT, TrEMBL, PIR, UniProt, PROSITE, PRINT, Pfam. Protein structure database – PDB, MMDB, SCOP, CATH, HSSP. Pathway database- KEGG, METACYC, Pathway commons, Genome Net -OMIM. GOLD , ULCAN, TCGA, miRNA database (MirDB, MirANDA, MirWalk), Cytscape. Primary database, secondary database, composite database. Database similarity searching: BLAST, psi BALST Multiple Sequence Alignment: Star Alignment Heuristics, Applications of MSA: PSSM, Profiles, Hidden Markov Model.	14 18
II	**Sequence Analysis –** Pairwise sequence alignment, Multiple sequence alignment, global sequence alignment and local sequence alignment. PAM, BLOSUM CADD, QSAR, Gene Ontology. **Structural and Functional Bioinformatics** Protein Tertiary Structure Prediction: homology modeling, Threading & Fold recognition, abintio, Introduction to Microarray technology (Affymatrix, Agilent, cDNA), Text Mining for information extraction from Biomedical Literature	24

Text Book:

- Bioinformatics: Principles & Application by Zhumur, Ghosh

Reference Books:

- Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science.
- Statistical Methods in Bioinformatics-Evens & Grants, Springer-Verlag, NY.
- Computational Molecular Biology- Setubal and Meidanis, PWS publishing Co.
- Protein Structure Prediction-A Practical Approach, MJE Sternberg, Oxford University Press.
- Purifing Protein for Protemics, Richard J. Sinpson, I.K. International Pvt. Ltd.

COURSE OUTCOMES: The major outcomes of this course are:

CO1: Ability to understand the computational methods, tools and algorithms employed for Biological Data Interpretation.

CO2: Understand the concept of pair wise sequence alignment, algorithms and tools for pair wise alignment.

CO3: Describe about Multiple Sequence Alignment, its significance, algorithms and tools used for MSA.

CO4: Describe about the various techniques, algorithms and tools used for Phylogenetic Analysis.

CO5: Ability to apply various computational methods and tools used for protein secondary structure prediction and genome analysis.

CO6: Able to classify different types of Biological Databases.

CO7: Understand the methods to characterize and manage the different types of Biological data.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1,PO2, PO3, PO4, PO7/PSO1, PSO2
CO2	
CO3	
CO4	
CO5	
CO6	
CO7	

MSBC0004: BIOPHYSICAL TECHNIQUES

OBJECTIVES: To provide scientific understanding of analytical techniques and detail interpretation of results.

Credits: 04 **Semester I** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	• **Microscopic techniques**: Principle of light microscopy, Phase contrast microscopy, Fluorescence microscopy, Scanning and Transmission Electron Microscopy, Staining procedures in light and Electron microscope, Confocal microscopy, Atomic force microscopy • Centrifugation: Principle, RCF, Rate Zonal and isopycnic density gradient centrifugation, Preparative and analytical ultracentrifuges, molecular weight determination, sedimentation analysis • **Chromatography techniques:** TLC, Gel filtration chromatography, Ion –Exchange chromatography, Affinity chromatography, Tandom affinity purification, Gas-liquid chromatography, HPLC	18
II	• **Electrophoresis techniques:** Principle and application of PAGE, SDS-PAGE, Iso-electric focusing, 2D electrophoresis, Agarose gel electrophoresis, Pulse Field Gel Electrophoresis, Orthogonal field alteration gel electrophoresis, Southern, Northern and Western blotting. • **Spectroscopic techniques:** Principle and application of UV, Visible and IR spectroscopy, Fourier transform IR spectroscopy, Fluorescence spectroscopy, ESR, NMR, Atomic absorption spectroscopy, Mass spectroscopy, Raman spectroscopy, ORD and CD spectroscopy, X-ray crystallography, Flow cytometry	24

Text Book:

- Biological Instrumentation & Methodology by Bajpai, P.K

Reference Books:

- Principle and Techniques in Biochemistryand Mol. Biology, by Keth, Wilson and Walker.
- Protein Purification Principle and Practices by Scopes, Robert K.
- Tools in Biochemistry David Cooper.
- Methods of Protein and Nucleic acid Research, OstermanVol I – III.
- Principle of Instrumentation analysis by Skoog& West.
- Biophysical Chemistry by Upadhyay&Nath.
- Physical Biochemistry: Application to Biochemistry and Molecular Biology by Freilder.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- The students recall the principle and applications of bioinstrumentation
CO2- The students will discriminate the principle, Instrumentation of different types of bioanalytical techniques
CO3- The students also discern about applying the instrumentation techniques of Centrifugation, Electrophoresis and Chromatography in various research fields.
CO4- Students can able to interpret the results obtained by these analytical techniques.
CO5- students will have the knowledge and skills to explain the theoretical aspects of key analytical techniques and instruments like electron microscopy, X-ray diffraction, mass spectrometry and other spectroscopic techniques.
CO6- The students will use the knowledge of concerning modern analytical instrumentation and can able to enter into large scale industries.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO2, PO3, PO4, PO7/PSO1, PSO2
CO2	PO1,PO5, PO6, PO7, PO8/PSO1, PSO2

MSBC: BIOSTATISTICS LAB

OBJECTIVES: The objectives of this course are to provide students in biomedical research programs familiarity with proper experimental design and basic biostatistics concepts for laboratory scientists, and to learn how to use different tools for graphing and data analysis

Credits: 02 **Semester I** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	**M.S excel** – central tendency, SD, SEM, T- test. **Prizm** dose-response curve , one way and two way anova, linear and non linear regression, Fisher Exact **SPSS**- chi squer co relation regression, Z scoring, skewness and kurtosis **JMP**- Big data analysis, intra-class correlation coefficient, correlation ratio.	15

COURSE OUTCOMES

CO1: Knowledge in Biostatistics - basic concepts, examples and applications of statistical methods in medicine, biology and public health, scale of measurements, statistical populations, sample from population, data collection - sampling methods.

CO2: Knowledge in Construction of statistical tables, frequency distribution, construction of frequency tables from raw data, cumulative frequency tables, diagrammatic and graphical representation of data, measures of central tendency, raw and central moments from grouped and ungrouped data, dispersion, skewness and kurtosis.

CO3: Knowledge in Attribute - definition and concepts, dichotomy, fundamental set of frequencies, consistency of data, conditions of consistency, independence and association of attributes.

CO4: Knowledge in Basic concepts, Scatter diagram, line of regression, correlation coefficient, fitting of regression lines, definition of Spearman's rank correlation coefficient, Kendall's tau, partial and multiple correlation and regression, tests for correlation and regression coefficients, intra-class correlation coefficient, correlation ratio.

CO5: Skill in descriptive statistics using software like SPSS

Text Books:

1 Medical Statistics - Principles & Methods: Sundaram K. R., Dwivedi S.N. & Sreenivas V.; 2009; BI Publications, New Delhi.

2 Statistics, A foundation for analysis in health science: Wayne W Daniel. 7th ed.; 1999; John Wiley.

Reference Books:

➢ Principles of medical statistics: Alvan R Feinstein; 2001; CRC press.

➢ A-Z of medical Statistics: Fiklomina Pereira Maxwell; 1998; Arnold Publishers.

➢ Basic Statistics and Pharmaceutical Statistical Applications: James E. De Muth; 1999; Marcel Dekker, Inc.

➢ Statistical Methods in Medical Research: P. Armitage, G. Berry & J. N. S. Matthews; 2002; 4th Ed., Blackwell science.

➢ Methods in Biostatistics: B. K. Mahajan; 1999; Jarpee brothers medical publishers Pvt. Ltd.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO2,PO4, PO5, PO7 /PSO2
CO2	PO1,PO4, PO6, PO7,PO8 /PSO1, PSO2
CO3	PO1,PO4, PO5, PO8 /PSO1

MSBC 0802: BIOINFORMATICS LAB

OBJECTIVES: Practical are designed to inculcate skill-sets in students to navigate biological databases and utilize bioinformatics software and ascertain them computational possibilities in biotechnology/microbiology**.**

Credits: 02 **Semester I** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	**Bioinformatics Resources** – NCBI, EBI, ExPASy, RCSB, DDBJ • Database searching against a query sequence and selection of orthologous sequences using BLAST • Multiple Sequence Alignment using Clustal W • Prediction of Open Reading Frames using ORF Finder • 3 Dimensional Structure of protein using Deep View • Phylogenetic Analysis using Phylip (Neighbor Joining and Maximum Likelihood) • Cytoscape • Structure visulation tool Pymol • Molecular docking - Protein – Ligand Dockig Mutation prediction Primer designing • Data Mining	15

COURSE OUTCOME: The major outcomes of this course are:

CO1- Students will be able to use tools and techniques of bioinformatics effectively.

CO2-knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics

CO3-Existing software effectively to extract information from large databases and to use this information in computer modelling

CO4 Problem-solving skills, including the ability to develop new algorithms and analysis methods

CO5-An understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1,PO2, PO4, PO5, PO7, PO8 /PSO2

MSBC0803: BIOCHEMISTRY & BIOPHYSICAL TECHNIQUES &LAB

OBJECTIVES: Biophysical techniques form the basis for all aspects of modern Biotechnology. The objective of the course is to advance the student's knowledge of spectroscopic, electrophoresis, chromatographic techniques and other current biophysical methods.

Credits: 02 **Semester I** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	• Introduction to the laboratory, good lab practices. • Introduction to instruments and glassware that are routinely used in the laboratory • Paper chromatography of carbohydrates • 2D paper chromatography • TLC of fatty acids/lipids • Gel Filtration: Determination Vo separation of Blue Dextran and Cobalt chloride or Protein and amino acid by Sepahdex-G10 • Separation of proteins by PAGE, SDS- PAGE • Agarose gel electrophoresis of nucleic acids • Estimation of proteins by Lowry's method and UV spectrophotometer • Microscopy: working of simple, compound, phase contrast microscopes, inverted microscopes • Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample • Cell counting with Haemocytometer • Sub Cellular fractionation by differential centrifugation and density gradient (sucrose/ percoll/ CsCI). •	**30**

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To understand fundamental concept of instrumentation
CO2- Describe the qualitative analysis of carbohydrates, lipids, protein and nucleic acid
CO3- To understand the quantitative analysis of carbohydrates, lipids, protein, nucleic acid and cholesterol

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO2, PO4, PO5, PO7, PO8 /PSO2
CO2	PO1,PO2, PO3, PO6, PO8/PSO1, PSO2
CO3	PO1, PO3, PO6, PO7/PSO1,

MSBC: MOLECULAR MODELING AND DRUG DESIGN

OBJECTIVES: The aim of the course is to emphasize molecular modelling and drug/receptor interaction to explore biological phenomena at the molecular level. Molecular modeling and docking, key to Computer-Aided Drug Design, enable the creation of effective drug agents, leading to a plethora of candidate drugs.

Credits: 04 **Semester II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Drug design** – Drug discovery process. Target identification and validation, lead optimization and validation. Methods and Tools in Computer-aided molecular Design, Analog Based drug design:- Pharmacophores (3D database searching, conformation searches, deriving and using 3D Pharmacophore, constrained systematic search, Genetic Algorithm, clique detection techniques, maximum likelihood method) and QSAR. **Structure based drug design**:- Docking, De Novo Drug Design (Fragment Placements, Connection Methods, Sequential Grow), Virtual screening, HTS.	18
II	**Structure Activity Relationship** – Introduction to QSAR, QSPR, Various Descriptors used in QSARs: Electronics; Topology; Quantum Chemical based Descriptors. Regression Analysis, The Significance and Validity of QSAR Regression Equations, Partial Least Squares (PLS) Analysis, Multi Linear Regression Analysis. Use of Genetic Algorithms, Neural Networks and Principle Components Analysis in the QSAR equations.	24

Text Book:

1. Malone, P.M., Kier, K.L., Srtanovich, J.E. Drug Information-A Guide for Pharmacists. McGraw-Hill, 2006.
2. Krishnan Namboori P K and Deepak O M. Computational Drug Design and Delivery systems-principles and applications, Springer. 2012.
3. Prasad V. Bharatam, Modeling and Informatics in Drug Design, John Wiley & Sons Inc.2007. 25
4. Tagelsir Mohamed Gasmelseid, Pharmacoinformatics and Drug Discovery Technologies: Theories and Applications, IGI-Global, 2012

Reference Books:

1. Advanced Concepts in Structural Bioinformatics: Structural Bioinformatics: Philip E. Bourne (Editor), HelgeWeissig (Editor). ISBN: 978-0-471-20199-1
2. Protein Structure Prediction: A Practical Approach (The Practical Approach Series , No 170) by Michael J. E. Sternberg
3. Computer-aided Drug Design: Practical Application of Computer-Aided Drug Design (Hardcover) by Charifson (Author)

COURSE OUTCOMES: The student who complete the course knows

CO1. Basics of drugs , the rules that govern drug behavior and its classification
CO2. Identify the drug targets and understand the mode of action.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO2, PO4, PO5, PO7, PO8 /PSO1, PSO2

MSBC – SEQUENCE ANALYSIS

OBJECTIVES: To introduce to the field of sequence analysis to extract features and functions and thus depict structure and evolution from genetic material

Credits: 04 **Semester II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	• Basics of genetics • Organization of Prokaryotic and Eukaryotic Genome. • DNA Replication machinery in Prokaryotes and Eukaryotes . Regulation of DNA replication. • DNA repair mechanism. • Transcription in prokaryotes and Eukaryotes, Reverse transcription. • RNA processing, and editing. Regulation of gene expression in prokaryotes: • Regulation of gene expression in eukaryotes: Activators, and Insulators, Chromatin Remodeling, Chemical Modifications of Histones: role of Histone Acetyl transferases, and Deacetylases, Signal Transduction and control of transcriptional regulation, microRNAs and their role in gene expression regulation • Genetic Code: Evidence and properties; Wobble hypothesis; Transcriptional adaptors and amino acyl tRNA synthases	18
II	• Translation: Successive stages of protein synthesis in prokaryotes and eukaryotes • Protein degradation via proteasomes • Post-translational Modification: Types and Significance • Genetic recombination in prokaryotes and eukaryotes and its molecular mechanism. • Transposable elements in Prokaryotes and Eukaryotes: Types and Significance • Chromosomal and gene mutation • Introduction and application of Molecular markers (RFLP,AFLP.RAPD,SNP, and VNTR) • Biomedical Genetics & its application • Modern molecular Diagnostic techniques. • Gene and protein sequencing and analysis	24

Text Book:

- Cell Biology, Genetics, Molecular Biology by Verma, P.S
- Molecular Biology by Friefelder, David

Reference Books:

- Albert B, Bray Denis et al.: Molecular Biology of The Cell.
- Watson, Hopkin, Roberts et al.: Molecular Biology of the Gene.

- Genetics- Strickberger.
- Microbial Genetics – D. Frifielder.
- Baltimore- Molecular Biology of the Cell.
- Benjamin Levin – Genes VIII.
- Advance Genetics by G.S. Miglani, Narosa Publishing House.

OUTCOME: After completing this course, student will able to

CO1.Understand characteristics of DNA and its primary, secondary and tertiary structure. ***(Understand)***
CO2.Understant Complexity and organization of genome in different organism. ***(Understand)***
CO3. Analyze the genetic code and describe the Translation and post translation modification process. ***(Understand and Analyse)***
CO4-To introduce to the field of sequence analysis to extract features and functions and thus depict structure and evolution from genetic material

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO2, PO4, PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1, PO2, PO4, PO5, PO7, PO8 /PSO1, PSO2

BIOTHERMODYNAMICS

OBJECTIVE: The aim of this core course is how thermodynamics can best be applied to applications and processes in biochemical engineering. It describes the rigorous application of thermodynamics in biochemical engineering to rationalize bioprocess development and obviate a substantial fraction of this need for tedious experimental work.

Credits: 04 **Semester II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Free energy concepts:** Introduction to Thermodynamics: Energy, Energy Transfer, First Law of Thermodynamics, Entropy, Second & Thrid Law of Thermodynamics, Gibbs energy, governing equations for Mass, Energy and Entropy in closed and open systems, Equation of state, intensive and extensive properties **Thermodynamic aspects of Biological processes:** Heat generation and energy dissipation of live cell growth process, thermodynamic prediction of kinetic parameters (e.g. yield coefficients, growth rate, specific rates, affinity constants), metabolic heat production, Gibbs energy dissipation for aerobic, fermentative and autotrophic cell growth, Biocalorimetry and its applications. Bio and Nano Machine **Thermodynamics of Metabolism:** Black box thermodynamic analysis of Dicarboxylic acid production (e.g. Fumaric acid, succinic acid), maximum theoretic product yield, alkali consumption, osmotic stress and ionic strength, ATP synthesis for growth, thermodynamic feasibility analysis of metabolic pathways.	18
II	**Application of first and second law of thermodynamics to biological systems.** Energy rich bonds - ATP and interconversions of nucleotide phosphates. Phosphorylation potential. **Mitochondria** Architecture, chemical activity of mitochondria, Sequence of electron carriers and sites of oxidative phosphorylation, ATP generation, heme and non- heme iron proteins **Thermodynamic considerations-** oxidation - reduction electrodes, standard electrode potential, redox couples, phosphate group transfer potential. **Respiratory controls.** Theories of oxidative phosphorylation, uncouplers and inhibitors of energy transfer. ATP synthetase complex.	

COURSE OUTCOMES

CO1- To explain the basic concepts of thermodynamics such as system, state, state postulate, equilibrium, process, and cycle.

CO2- To understand the concept of heat, work, and basic principles of thermodynamics.

CO3- know the molecular origins of the Boltzmann distribution, the Arrhenius rate law, and entropic forces. They will understand how thermal motion constrains in biological systems.

CO4- Understand the thermodynamic background for diffusion, chemical reactions and chemical kinetics in biological systems.

CO5- Apply the mathematical framework of thermodynamics to understand basic processes of self-assembly, binding and recognition for biological systems.

CO6- Students will be able communicate information and their knowledge in biothermodynamics.

Text Books

1. Urs von Stockar, Biothermodynamics: The role of thermodynamics Biochemical Engineering, CRC Press, 2013.
2. Stanley I Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4th Ed., Wiley Publishers, 2006.

References

1.Mustafa Ozilgen, Esra Sorguven, Biothermodynamics principles and applications, CRC Press, 2017
2. J.M Smith, H.C Van Ness and M.M Abott, Introduction to Chemical Engineering Thermodynamics, McGraw Hill (4th Ed), 1987.

PROGRAMMING IN PYTHON

OBJECTIVE: The course is designed to provide Basic knowledge of Python. Python programming is intended for software engineers, system analysts, program managers and user support personnel who wish to learn the Python programming language.

Credits: 04 **Semester II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction, Data Types and Operators:** Installation and working with Python, Variables and data types in python, perform computations and create logical statements using Python's operators: Arithmetic, Assignment, Comparison, Logical, Membership, Identity, Bitwise operators, list, tuple and string operations **Python Decision making and Loops:** Write conditional statements using If statement, if ...else statement, elif statement and Boolean expressions, while loop, for loop, Nested Loop, Infinite loop, Break statement, continue statement, Pass statement, Use for and while loops along with useful built-in functions to iterate over and manipulate lists, sets, and dictionaries. Plotting data, Programs using decision making and loops	18
II	**Python Functions and Modules:** Defining custom functions, Organizing Python codes using functions, Create and reference variables using the appropriate scope, Basic skills for working with lists, tuples, work with dates and times, get started with dictionaries, importing own module as well as external modules, Programming using functions, modules and external packages **Python File Operations**: An introduction to file I/O, use text files, use CSV files, use binary files, handle a single CLO4 L T P Cr 3 0 0 3 18 exception, handle multiple exceptions, Illustrative programs. Learning Activities: Problem Solving code practice based on CSV files	24

COURSE OUTCOMES

CO1-To understand why Python is a useful scripting language for developers.

CO2-To learn how to design and program Python applications.

CO3-To learn how to use lists, tuples, and dictionaries in Python programs.

CO4-To learn how to identify Python object types.

CO5-To learn how to use indexing and slicing to access data in Python programs.

CO6-To learn how to build and package Python modules for reusability.

MSBC0007: CHEMINFORMATICS

OBJECTIVES: The objective of this course is to provide introduction to cheminformatics, an interdisciplinary area on the interface of chemistry, informatics and biology. The student will be provided with understanding of fundamentals of cheminformatics and its applications. Through lectures, hands-on exercises and assignments, the student is expected to achieve a good grasp of the concepts and applications of cheminformatics.

Credit: 04 **Semester II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	Cheminformatics as a theoretical chemistry discipline: definition, main concepts and areas of application. **Representing chemical structures on computers**. Molecular graphs. Connectivity tables. ChemDraw, Chemsketch Adjacency and distance matrices. Linear representations SMILES and SMIRKS. Hashed fingerprints. Exchange formats for chemical structures (MOL, SDF) and reactions (RXN et RDF). Chemical Databases. Different types of searching structures in the databases: exact match, sub-structural, super- structural and by similarity. **Molecular descriptors.** Definition and main requirements. Different types of descriptors: constitutional, topological indices, geometry-based, surface based, substructural fragments, lipophilicity, etc. Development and validation of QSAR/QSPR models. Data preparation. Statistical parameters assessing models performance. Cross- CLO2 validation. Models applicability domain. Ensemble modeling. Molecular Interaction Fields. 3D QSAR. Molecular fields' similarity Pharmacophore approach Pharmacophore features. Ligand- and structure-based pharmacophores. Merged and shared pharmacophores. Pharmacophore-based virtual screening	18

II	**Chemical Space concept**. Graph-based chemical space: scaffolds, frameworks and R-groups. Scaffold tree approach. Descriptor-based chemical space: distance and similarity metrics. Data visualization: Generative Topographic Mapping. Network-like similarity graphs. Activity landscapes. Bioisosteres. Activity cliffs. **Virtual screening workflow**. Drug-likeness filters and structural alerts. Parameters of screening efficiency.	24

Course Outcome

CO1-Students are able to explain basic concepts of chemoinformatics.
CO2-Students are able to explain and implement computation of molecular descriptors and chemical similarity.
CO3-Students are able to classify small molecules and interpret results from chemoinformatics analysis.

Text Books

1. Applied Chemoinformatics: Achievements and Future Opportunities, 2018, Engel & Gasteiger (Editors). Wiley, Amazon.
2. Chemoinformatics: Basic Concepts and Methods, 2018, Engel & Gasteiger (Editors). Wiley, Amazon .
3. In Silico Medicinal Chemistry, 2016, Nathan Brown. RSC Publishing, Amazon.

Reference books

1. Introducing Cheminformatics, 2013, David Wild. LuLu, Amazon (Kindle)
2.Handbook of Chemoinformatics Algorithms, 2010, Faulon & Bender. CRC, Amazon
3.An Introduction to Chemoinformatics, 2003, Leach & Gillet. Springer, Amazon.
4.Chemoinformatics: A Textbook, 2003, Gasteiger & Engel, Wiley, Amazon.

COs	POs/ PSOs
CO1	PO1, PO2, PO4, PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1, PO3, PO4, PO5, PO6, PO7, PO8 /PSO1, PSO2

MSBC : PYTHON PROGRAMMING LAB

OBJECTIVES: The objective of this program is to demonstrate about Python data structures like Lists, Tuples, Sets and dictionaries and also to understand about Functions, Modules and Regular Expressions in Python Programming.

Credits: 02 **Semester II** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	Programs based on the concepts of: □ Building Python Modules □ Obtaining user Data □ Printing desired output Programs based on the concepts of: □ Conditional if statements □ Nested if statements □ Using else if and elif Programs based on the concepts of Iteration using different kinds of loops Usage of Data Structures □ Strings □ Lists □ Tuples □ Sets □ Dictionary Program based on the concepts of User-defined modules and Standard Library (random, numpy, scipy, sys, Math Module, String Module, List Module). Program based on Input Output. Program based on exception Handling. Program based on Simple Data analysis. Program based on Pandas.	**30**

COURSE OUTCOMES: Student should be able

CO1-to understand the basic concepts scripting and the contributions of scripting language

CO2- Ability to explore python especially the object oriented concepts, and the built in objects of Python.

CO3- Ability to create practical and contemporary applications such as TCP/IP network programming, Web applications, discrete event simulations

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO4 PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1, PO3, PO4, PO6, PO7, PO8 /PSO1, PSO2

MSBC : SEQUENCE ANALYSIS LAB

OBJECTIVES: To well verse the students with practical knowledge of molecular biology that they have taught in the theory and provide hands on training on practical techniques of molecular biology related practical.

Credits: 02 **Semester II** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	Exercices: 1. Sequence Databases: EMBOSS, NCBI ToolKit, Expassy tools 2. Search tools against Databases: i. BLAST ii. FASTA a. Dot Plot b. Global and Local alignment methods 4. Multiple sequence alignment: a. Clustal b. Dialign c. Multalign 5. Primary and secondary structure prediction methods a. GOR Method b. PSI-pred c. Chou-Fasman method Binding site identification Sequence patterns and profiles: a. generation of sequence profiles i. PSI-BLAST b. derivation of and searching sequence patterns: i. MEME/MAST ii. PHI-BLAST iii. SCanProsite iv. PRATT 8. Protein motif and domain analysis: a. MEME/MAST b. eMotif c. InterproScan d. ProSite e. ProDom f. Pfam 9. Phylogentic analysis – Mega, Paup, phylip	**30**

COURSE OUTCOMES: After completion of module student will be able-

CO1- To perform different molecular techniques for isolation of DNA, RNA etc.
CO2- In addition to these students will be able to perform various methods for demonstrationand handling of virus.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO4 PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1, PO3, PO4, PO6, PO7, PO8 /PSO1, PSO2

MSBC : MOLECULAR MODELING AND DRUG DESIGNING LAB

OBJECTIVES: To well verse the students with practical knowledge of molecular biology that they have taught in the theory and provide hands on training on practical techniques of molecular biology related practical.

Credits: 02 **Semester II** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	1. Molecular Visualization: Pymol and Chimera • • Pdb file format and Parsing • • Visualizing a molecule in different representations • • Identifying interacting residues (protein and ligand interactions) • • Measuring distances between atoms • • B-factor visualization • • Image tracing and preparation 2. Small Molecule sketching using Marvin sketch and bond optimization in 2D & 3D format • SDF, MOL2 file formats 3. Geometry Optimization using SwissPdb Viewer • • Energy Minimization of protein molecule • • Determining Maxima and Minima energy points 4. Binding Site Identification • • Different approaches for binding site identification • • Tools - Cast-P, POCASA, 3D ligand site, Metapocket, Ghecom 4. Structure based Drug design • • Molecular docking using AutoDock • • Virtual Screening using AutoDock Vina 5. Molecular Dynamics Simulation • • Protein dynamics using Gromacs • • Protein-ligand complex MD simulation 6. Ligand Based drug design • QSAR	**30**

COURSE OUTCOMES: After completion of module student will be able-

CO1- To perform different molecular techniques for isolation of DNA, RNA etc.
CO2- In addition to these students will be able to perform various methods for demonstrationand handling of virus.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO4 PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1, PO3, PO4, PO6, PO7, PO8 /PSO1, PSO2

SEM III

MSBE 0001: DATA MINING AND MACHINE LEARNING

OBJECTIVES:

- The mission of the Nanobiotechnology Program is to provide a multidisciplinary education in nanoscale science and technology. The primary goals are:
- Prepare students for a career in nanotechnology by providing them with a sound grounding in multidisciplinary areas of nanoscale science and engineering.
- Increase students' understanding of materials and their properties.

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction**, Importance of Data Mining, Relational Databases, Data Warehouses, Transactional Databases, Advance Database Systems and Applications, Data Mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining. **Primitives and System Architectures** – Data Mining Primitives, Data Mining Query Language, Designing Graphical User, Interfaces Based on a Data Mining Query Language, Architectures of Data Mining Systems. **Concept Description and Association Rules** – Concept Description, Characterization and comparison, Data Generalization and Summarization-Based Characterization, Analytical Characterization, Mining Class Comparisons, Mining Association Rules in Large Databases, Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases.	10
II	**Classification and Prediction** – Classification and Prediction, Issues: Data preparation for classification and Prediction, Comparing classification Methods, Classification by Decision Tree Induction: Decision Trees and Decision Tress induction **Clustering Methods** – Clustering Analysis, Types data in clustering analysis: Scaled variable, Binary variables, Variables of Mixed Types, Partitioning Methods: K-means and K-Medoids, Model-Based Methods, Data Mining Applications: Data mining for Biomedical and DNA Data Analysis	14

Text Book:

Data Mining Concepts and Techniques – Jiawei Hen, Micheline Kambler, Academic Press Morgan Kaufman Publishers. 2006

Reference Books:

1. Data Mining: Practical machine learning tools Techniques with java implementation by Ian H.Witten, Eibe Frank, 2005.
2. Machine Learning and data mining in pattern recognition in third International conference MLDM, by Petra Perner and Azriel Rosenfield, Springer.2003

COURSE OUTCOMES:

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

CO1- The necessary foundation for training in research.
CO2- Provide theoretical and practical knowledge related to modern nanotechnology.
CO3- On completing master's degree, should be capable of reflecting on central, ethical and scientific problems related to nanobiotechnology.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PO7, PO8 /PSO1, PSO2
CO2	PO2, PO3, PO4, PO5, PO6, PO7/PSO1, PSO2
CO3	PO1, PO2, PO3, PO4, PO5, PO6, PO7/PSO1, PSO2

MSBE 0006: GENOMICS AND PROTEOMICS

OBJECTIVES: To demonstrate an understanding of the importance of strict quality control and regulation in the drug development process, and an awareness of issues associated with the manufacturing of medicines such as good manufacturing practice.

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Genomics and Metagenomics** – Large scale genome sequencing strategies. Genome assembly and annotation. Genome databases of Plants, animals and pathogens. Metagenomics: Gene networks: basic concepts, computational model such as Lambda receptor and lac operon. Prediction of genes, promoters, splice sites, regulatory regions: basic principles, application of methods to prokaryotic and eukaryotic genomes and interpretation of results. Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps **Comparative genomics** – Basic concepts and applications, whole genome alignments: understanding the significance; Artemis, BLAST2, MegaBlast algorithms, PipMaker, AVID, Vista, MUMmer, applications of suffix tree in comparative genomics, synteny and gene order comparisons Comparative genomics databases: COG, VOG	
II	**Functional genomics** – Application of sequence based and structure-based approaches to assignment of gene functions – e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc. Use of various derived databases in function assignment, use of SNPs for identification of genetic traits. Gene/Protein function prediction using Machine learning tools viz. Neural network, SVM etc P**roteomics** – Protein arrays: basic principles. Computational methods for identification of polypeptides from mass spectrometry. Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools available at Proteomics server); databases (such as InterPro) and analysis tools. Protein-protein interactions: databases such as DIP, PPI server and tools for analysis of protein-protein interactions	14

MSBE 0001: NANOBIOTECHNOLOGY

OBJECTIVES:

- The mission of the Nanobiotechnology Program is to provide a multidisciplinary education in nanoscale science and technology. The primary goals are:
- Prepare students for a career in nanotechnology by providing them with a sound grounding in multidisciplinary areas of nanoscale science and engineering.
- Increase students' understanding of materials and their properties.

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	Basic biology principles and practice of micro fabrication techniques, Atomic force microscopy, Biological production of metal nano particles, macro molecular assemblies, quantum dots technology and its application, Application in Biomedical and biological research, tumor targeting and other diagnostic applications.	10
II	Viruses as nano-particles ,nano chemicals and application, Developing drug delivery tools through nano biotechnology, nano particle based immobilizationassays. Synthesis and characterization of different classes of biomedical polymers- their uses in pharmaceutical, cardiovascular ophthalmologic, orthopedic areas. Biosensors and nano biotechnology principles used in construction of micro electronic devices ,sensors and macro mechanical structuresand their functioning, immuno-nanotechnology	14

Text Book:

1. SubbaihBalaji,“Nano Biotechnology”:MJP Publishers, 2010

Reference Books:

1. Christof M. Niemeyer , Chad A. Mirkin,“Nanobiotechnology - concepts, applications and perspectives”: wiley publishers,2004.
2. Donald Martin,”Nanobiotechnology of biomimetic membranes”: springer verlag publishers, 2007.

COURSE OUTCOMES: After completion of course, the student will be able to:

CO1- The necessary foundation for training in research.
CO2- Provide theoretical and practical knowledge related to modern nanotechnology.
CO3- On completing master's degree, should be capable of reflecting on central, ethical and scientific problems related to nanobiotechnology.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PO7, PO8 /PSO1, PSO2
CO2	PO2, PO3, PO4, PO5, PO6, PO7/PSO1, PSO2
CO3	PO1, PO2, PO3, PO4, PO5, PO6, PO7/PSO1, PSO2

MSBE 0006: R LANGUAGE AND BIG DATA ANALYTICS

OBJECTIVES: To demonstrate an understanding of the importance of strict quality control and regulation in the

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Overview of the R language** – Defining the R project, Obtaining R, Generating R codes, Scripts, Text editors for R, Graphical User Interfaces (GUIs) for R, Packages. **R Objects and data structures** – Variable classes, Vectors and matrices, Data frames and lists, Data sets included in R packages, Summarizing and exploring data, Reading data from external files, Storing data to external files, Creating and storing R workspaces. **Manipulating objects in R** – Mathematical operations (recycling rules, propagation of names, dimensional attributes, NA handling), Basic matrix computation (element-wise multiplication, matrix multiplication, outer product, transpose, eigenvalues, eigenvectors), Textual operations, Basic graphics (high-level plotting, low-level plotting, interacting with graphics).	10
II	**Hypothesis testing and data handling** – Hypothesis testing, Parametric and nonparametric tests, Chi-square test, t-tests, ANOVA, Correlation and regression, Principal component Analysis **Big Data Analytics in Bioinformatics using R**: Introduction to Big data: Characteristics, data structures and data repositories; exploratory analysis of big data in R environment, Bioconductor, Microarray and next-generation sequencing (NGS) data analysis in R environment.	14

Text Book:

- Bioinformatics, second edition M.M. Ranga

Reference Books:

- Basic Principles of Drug Discovery and Development by Benjamin Blass

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Compare and **understand** common natural sources of drugs and contemporary approaches to drug design and development

CO2- **Demonstrate** an **understanding** of the timelines and resources required to discover and develop new drugs in a preclinical setting

CO3- **Demonstrate** an **understanding** of the critical features of each stage of the preclinical drug development process

CO4- **Demonstrate** an **understanding** of the environment and drivers of drug discovery and commercialisation of research

CO5- **Demonstrate** an **understanding** of population, gender and ethnic differences in drug action and metabolism

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1,PO3, PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1,PO2, PO4, PO6, PO7, PO8 /PSO2

SYSTEM & STRUCTURAL BIOLOGY

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction & Biological Networks** – Systems Biology: Emergent property, Applications in health and diseases. Microarrays and its applications in systems biology. Self-organizing maps and Connectivity maps-definition and its uses. Biological Networks: Degree distribution, Clustering coefficient, Random networks, Scale-free networks, small-world effect. **Simulation of pathways** – Metabolic network, Metabolic reconstruction, Flux Balance Analysis (FBA): Translating biochemical networks into linear algebra, Stoichiometric matrix, Elementary mode, Extreme pathways, Objective function, Optimization using linear programming. Genomescale cellular models: Virtual Erythrocytes, Global human metabolic model (Recon 1). **Databases and software for Systems Biology** – Introduction-databases: EMP, MetaCyc. Expression databases and other databases related to systems biology. visANT & Cell Designer.	10
II	**Xray Crystallography** – Electromagnetic radiation, X-rays, principles, Bragg's Law, Types of solids: Crystal and amorphous, solids, Crystal Systems: Seven crystal system, Bravies Lattices, Space group, Symmetry. Crystallization Techniques: Small and Protein Molecules. **Cryo EM**, Basics of CryoEM, GPCR biology **Structure Prediction Strategies** – Secondary structure prediction: Algorithms viz. Chou Fasman, GOR methods; analysis of results and measuring the accuracy of predictions using Q3, Segment overlap, Mathew's correlation coefficient Identification/assignment of secondary structural elements from the knowledge of 3-D structure of macromolecule using DSSP and STRIDE methods **Classification and comparison of protein 3D structures** – Purpose of 3-D structure comparison and concepts; Algorithms such as FSSP, CE, VAST and DALI, Fold Classes. Databases of structure-based classification: CATH and SCOP. Structures of oligomeric proteins and study of interaction interfaces	14

Text Books:

1. Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, Chapman & Hall/CRC, 2007.
2. Synthetic Biology: A Primer by P.S. Freemont & R.I. Kitney, Imperial College Press, 2012.
3.Molecular Modeling Principles and Applications (2nd Ed.) by Andrew R. Leach., Prentice Hall, USA. 2001

4. Principles of Protein Structure by G. E. Schulz., Springer 2009
5. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox, W. H. Freeman.2005

Reference Books:

1. Introduction to Systems Biology, S. Choi, Humana Press, 2007.
2. Linked – The New Science of Networks, Albert-László Barabási, Perseus Publishing, 2002.
3. Networks – an Introduction, Mark Newman, Oxford University Press, 2010.

ARTIFICIAL INTELLIGENCE IN BIOINFORMATICS

Course Objectives: The main objectives of this course are to:

1. To understand the various computational techniques with Artificial Intelligence.
2. To analyze biological data with the use of sequence information. 3. To understand the steps involved in Evolutionary analysis.
4. Also helps to start error free sequence analysis investigation successfully

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Artificial Intelligence (AI)** Introduction: Definition, Challenges and Applications. Role of AI in bioinformatics. . **Evolutionary / Phylogenetic Analysis:** Overview of Tree analysis. Cladistics, Phenetics and Distances. Various tree types. Overview of Bootstrapping. Tools – Clustal Omega, PHYLIP and Mega. Problems and errors in phylogenetic reconstruction. Overview of AI in Phylogenetic analysis	10
II	**Artificial Intelligence (AI):** Practice and implications of AI in Healthcare industry. Algorithms for Bioinformatics prediction: HMM and Neural Network. Case study: AI in computational sequence analysis.	14

Text Book(s)

1 S.C. Rastogi et al. Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery) Kindle Edition.
2 Stuart Russel and Peter Norvig, “Artificial Intelligence- A Modern Approach”, Prentice Hall, 1995.

Reference Books

1 Andreas D. Baxevanis and B.F. Francis Ouellette. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. ISBN: 978-0-471-47878-2.
2 George F Luger, “Artificial Intelligence”, Pearson Education, 4th Edition, 2001.

CLINICAL RESEARCH IN MEDICINAL PLANTS

Aim of the course: To introduce students to opportunities in Medicinal plant cultivation, harvesting, storage and marketing of the medicinal plants with market demand

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction to medical practices in India:** History – Literatures and physicians of ancient period. Outlines of Ayurvedha, Siddha, Unani and Homeopathic systems of traditional medicine. Role of AYUSH, NMPB, CIMAP and CDRI. Importance and Future prospects of medicinal plants. Conservation and sustainable use of medicinal plants, Gene banks of medicinal plants **Ethnobotany and Folk lore medical practices:** Role of medicinal plants in traditional and modern system of medicine - methods of documenting the ethnobotanical knowledge – AICRP-MAP. Cultivation and processing of medicinal plants: Propagules (Seed, leaf, stem, root, rhizome and bulbs, micropropagation) – cultivation methods – organic farming practices of medicinal plants - harvesting – processing – Grading -packaging – storage. Medicinal plants in commercial products Adulteration of plant crude drugs and methods of identification - some examples.	18
II	**An overview of selected medicinal plants:** Morphology, family, vernacular, botanical name, useful part, uses active principles and phytotherapeutics. **Whole plant** (*Phyllanthus amarus, Bacopa monnieri, Scoparia dulcis*) **Root** (*Asparagus racemosus, Rauwolfia serpentina & Gloriosa superba*) **Leaf** (*Aloe vera, Azadirachta indica)* ***Bulb****(Allium cepa, Allim sativum*) **Rhizome**(*Zingiber officinale, Curcuma longa*) **Fruit** (*Solanum nigrum, Solanum xanthocarpum, Phyllanthus emblica*) **Seed**(*Trigonella foenum graceum.Cuminum cyminum*) **Oil seed** (*Cocos nucifera, Ricinus communis*) **Plant Pharmacology:** Ethnopharmacology, Ecopharmacology, Reverse pharmacology, Photopharmacology, Drug repositioning, Biosimilars, Hemovigilance, Cosmetovigilance, Materiovigilance, Therapeutic audit, Pharmacoeconomics, Pharmacoepidemiology, Drug utilization studies, Drug information services, Translational pharmacology .	24

Expected Course Outcomes: On the successful completion of the course, student will be able to:

1 To do the sequence analysis and phylogenetic prediction with their own knowledge.
2 Also capable to search the protein/gene sequence and structural information from the any biological databases.
3 Helps to ensure the comparative sequence analysis without any error.
4 To analyze and interpret the biological data through Artificial Intelligence.

Reference Books

1. Akerele, O., Heywood, V. and Synge, H., (1991) The conservation of medicinal plants. Cambridge university press. Cambridge..
2. Chevallier, A., (1996) The encyclopedia of medicinal plants. D.K publishing, Michigan.
3. Cunningham, A.B., (2001) Applied ethnobotany- people, wild plant use and conservation. Earth scan publications limited, London.
4. Jain S.K., (1995) Manual of Ethnobotany, Scientific Publishers, Jodhpur,
5. Joshi, S. G. (2000) Medicinal Plants. Oxford and IBH, New Delhi.
6. Kokate, C. and Gokeale (2021) Pharmocognocy- Nirali Prakashan, NewDelhi.

Text Books

1. Singh M.P. (2003) Indigenous Medicinal Plants Social Forestry & Tribals
2. Sivarajan V.V. and Balachandran I. (1994) Ayurvedic Drugs and their Plant Sources, Oxford & IBH Publications.
3. Wallis, T.E., (1997) Text book of pharmacognosy, Fifth edition. CBS publishers, New Delhi.

BIOINFORMATICS APPLICATIONS TO PROTEIN STRUCTURE

OBJECTIVES:

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Protein folding problem**, protein folding classes, 2.3 protein identification and characterization:- AACompIdent, TagIdent, PepIdent and MultiIdent, PROSEARCH, PepSea, PepMAPPER, FindPept, **Predicting transmembrane helices**, Primary structure analysis and prediction, Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search. Methods of sequence based protein prediction.	10
II	**Energy minimization**, local and global minima, saddle point, grid search. various approximations; LCAO, HF, semi-empirical calculations; single point calculations, full-geometry optimization methods, ZDO. **Conformational search**, Z-matrix, docking, molecular modeling packages. **Molecular dynamics:**-Introduction, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzman velocity, time steps, duration of the MD run. Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions.	14

IMMUNO-INFORMATICS

OBJECTIVES: The main objectives of this course are to:

1. Make the students understand the immune system, its components and their functions.
2. Provide fundamental knowledge in Immunoinformatics databases and tools.
3. Learn the informatics-based approaches for prediction of Epitopes, design of vaccines and immuno-diagnostic tools.

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**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 peptidesSpecificity, 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. **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.	10
II	**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.	14

Expected Course Outcomes: On the successful completion of the course, student will be able to: 1 Describe the mechanism of Immune response and antibody production
2 Understand the molecular interactions between antigen and antibody.
3 Interpret the Methods to predict MHC and B-cell epitopes
4 Knowledge on different tools and servers for vaccine designing.
5 Explain the role of the immune molecules in infectious diseases and cancer

Text Book(s)

1 Richard Coico, Geoffrey Sunshine, "Immunology: A short course" 6th Edition. Wiley-Blackwell, 2009.
2 Darren R Flower, "Immunoinformatics: Predicting Immunogenicity in Silico", Humana Press, 2007.
3 Roitt Ivan, Delves Peter. Roitt's Essential Immunology 10th Edition. Publisher: Canada, Blackwell. 2001.

Reference Books

1 Thomas J. Kindt , Barbara A. Osborne , Richard A. Goldsby , " Kuby Immunology", WH Freeman, Sixth Edition, 2006.
2 Rammensee, "Immunoinformatics - Bioinformatics Strategies for better understanding of Immune Function", Wiley, 2003.

MSBE0007: IPR, PATENT, TRADEMARKS & BIOETHICS

OBJECTIVES: Intellectual property rights enlightens the student knowledge towards the development of novel ideas and goods in the field of biotechnology

Credits: 2 **Semester III** **L–T–P: 2-0-0**

Module No.	Content	Teaching Hours
I	**IPR :**Introduction to IPR, History of IPR in India. Essential elements of IPR- Trade secret, Patent, Copyright, Trademark. International harmonization of patent laws – WTO, GATT, TRIPs, WIPO. India and TRIPs, Protection of biotechnological inventions, IPR and developing countries, Broad patents in biotechnology, Choice of IPR protection, Management of IPR , Benefits and problems from IPR, Indian response to IPR upheaval. **Biosafety-** Introduction to Biosafety, Definition and objectives of biosafety guidelines. Risk Assessment- Assessment of risk during laboratory research, Risk Assessment of Biotechnolohy products. Risk regulation. Containment- Physical containment, Biological containment.	10
II	Biosafety guidelines in India, Biosafety Level – BL1, BL2, BL3 and BL4. Research involving plants – BL1-P, BL2-P, BL3-P and BL4-P. Research involving Animals- BL1-N, BL-2N, Bl3-N and BL4-N. **Bioethics-** Bioethics in Biodiversity Resource management – Definition, Ethical issues of biodiversity. Ethical issues in genetically modified organisms- Introduction, History of genetic modification, Techniques of genetic modification, Uses of genetic modification. Genetically modified food, Health implications of genetically modified food, Public health principles regarding the regulation of genetically modified food. Labeling of genetically modified food products. Benefits of labeling, Guidelines for labeling of genetically modified agricultural products. Animal cloning and their ethical aspects.	14

Text Book

- Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press.ISBN-1555811804,9781555811808.

Reference Books:

- Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219
- Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007) ISBN: 075069440, 9780750694445.
- Intellectual property rights-Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602, B.D. Singh. Biotechnology expanding horizons
- Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic ress..
- H.K.Das. Text book of biotechnology 3rd edition

OUTCOME: Students will be able to

CO1-Remember the historical perspective of patenting, intellectual property rights in the field of biotechnology. ***(Understand and Remembering)***
CO2- Understand the process of patent filing. ***(Understand)***
CO3- Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life. ***(Understand)***
CO4- Understand the importance of biosafety practices and guidelines in research. ***(Understand)***
CO5- Comprehend benefits of GM technology and related issues. ***(Understand and Remembering)***
CO6- Analyze importance of protection of new knowledge and innovations and its role in business. ***(Understand and Analyze)***
CO7- Analyze the case study of different patents and IPR related disputes. ***(Understand and Analyze)***
Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1,PO3, PO5, PO7, PO8 /PSO1, PSO2

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MSBE 0801: NANOBIOTECHNOLOGY LAB

OBJECTIVES: The objective of this laboratory includes synthesis, production and applications of nanoparticles.

Credits: 2 **Semester III** **L–T–P: 2-0-0**

Module No.	Content	Lab Hours
I	• Chemical Synthesis of silver Nano Particales (sodium borohydride) • Chemical Synthesis of silver Nano Particles (trisodium citrate) • Characterization of silver Nano Particles (By UV spectrophotometer) • Antibacterial activity of silver Nano Particles • Biological Synthesis of silver Nano Particles • Chemical Synthesis of Gold Nano Particles (Citrate Synthesis) • Characterization of Gold Nano Particles (By UV spectrophotometer • Antibacterial activity of gold Nano Particles • Biological Synthesis of gold Nano Particles	15

COURSE OUTCOMES: After completion of course, the student will be able to:

CO1- To have knowledge of nano material properties and characterization.
CO2- To use the tools, techniques and skills necessary to practice.
CO3- To understand of the impact of nano materials on the environment.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1,PO3, PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1,PO2, PO3, PO5, PO7, PO8 /PSO1
CO3	PO1,PO4, PO6, PO7, PO8 /PSO1, PSO2

MSBE 0803: CLINICAL RESEARCH IN MEDICINAL PLANTS LAB

OBJECTIVES: To understand the medicinal values of plants

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I	• Authentication of Medicinal plants • Importance of seasons, climate and other environment factors on components of medicinal plants • Preparation of different parts of medicinal plants for their extract preparation • Methods used for preparation of plant extract • Phytochemical analysis of plant extract • Quantitative estimation of component(s) of plants of medicinal value	15

COURSE OUTCOMES: After completion of course, the student will be able to:

PO1- To have knowledge of traditional medicine (ayurveda and its role) in treatment of diseases.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1,PO2, PO3, PO5, PO6, PO8 /PSO1, PSO2

R LANGUAGE AND BIG DATA ANALYSIS LAB

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I	1. Create a vector in R and perform operations on it. 2. Create integer, complex, logical, character data type objects in R and print their values and their class using print and class functions. 3. Write code in R to demonstrate sum(), min(), max() and seq() functions. 4. Write code in R to manipulate text in R using grep(), toupper(), tolower() and substr() functions. 5. Create data frame in R and perform operations on it. 6. Import data into R from text and excel files using read.table () and read.csv () functions. 7. Write code in R to find out whether number is prime or not. 8. Print numbers from 1 to 100 using while loop and for loop in R. 9. Write a program to import data from csv file and print the data on the console. 10. Write a program to demonstrate histogram in R. •	15

GENOMICS & PROTEOMICS LAB

COURSE OBJECTIVES: This course aims to provide the knowledge and practical skills of functional genomics and proteomics

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I	1. Protein Function Prediction (sequence-based, structure-based) 2. Comparative Genomics 3. Phylogenetic Analysis 4. (CLUSTAL, PHYLIP) 5. Genome Viewers, SNP Analysis 6. Microarray Analysis 7. Protein Structure Prediction 8. Proteome Analysis 9. Network & Pathway Analysis 10. Calculation of phi and psi angles in proteins.	15

R LANGUAGE LAB

OBJECTIVES: This lab course is designed to deal intensively with writing and testing functions in R.

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Teaching Hours
I	1.Download and install R-Programming environment and install basic packages using install.packages() command in R. 2. Learn all the basics of R-Programming (Data types, Variables, Operators etc,.) 3. Write a program to find list of even numbers from 1 to n using R-Loops. 4. Create a function to print squares of numbers in sequence. 5. Write a program to join columns and rows in a data frame using cbind() and rbind() in R. 6. Implement different String Manipulation functions in R. 7. Implement different data structures in R (Vectors, Lists, Data Frames) 8. Write a program to read a csv file and analyze the data in the file in R. 9. Create pie chart and bar chart using R. 10. Create a data set and do statistical analysis on the data using R.	

CO 1 Setup R Programming Environment.
CO 2 Understand and use R – Data types.
CO 3 Understand and use R – Data Structures.
CO 4 Develop programming logic using R – Packages.
CO 5 Analyze data sets using R – programming capabilities

ARTIFICIAL INTELLIGENCE IN BIOINFORMATICS LAB

COURSE OBJECTIVES: The aim of this course is to teach students the fundamental concepts and principles of AI as well as advanced techniques of AI.

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Teaching Hours
I	1.Artificial Neural Network exercises 2. Genetic Algorithm/Programs 3.Fuzzy Logic Programs 4.Feature selection/Extraction 5.Protein structure prediction 6. Classification 7. Clustering 8. Regression/Non-linear models	

CO1 Understand the informed and uninformed problem types and apply search strategies to solve them.
CO2 Apply difficult real life problems in a state space representation so as to solve them using AI techniques like searching and game playing.
CO3 Design and evaluate intelligent expert models for perception and prediction from intelligent environment.
CO4 Formulate valid solutions for problems involving uncertain inputs or outcomes by using decision making techniques.
CO5 Demonstrate and enrich knowledge to select and apply AI tools to synthesize information and develop models within constraints of application area.
CO6 Examine the issues involved in knowledge bases, reasoning systems and planning

RESEARCH METHODOLOGY

Objective: The objective of this course is to familiarize the scholars with the concept and the techniques of research methodology applicable to develop broad comprehension of research area.

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Teaching Hours
I	Research, concept, objectives, types (qualitative and quantitative), basis of scientific research. Research problems – Criteria for selecting a problem, choosing a methodology. Literature review – process, journals, books, patents and proceedings Research Ethics and Integrity; **Research Design:** Concepts, importance, types , experimental design (Randomized, Randomized block and factorial design). Measurement- concept, problems and levels. **Application of probability** - variables, normal and binomial distribution; Sampling- types, size, mean and variance of a sample Hypothesis testing- null and alternative hypothesis; Levels of significance; P-value, paired-t test; Analysis of variance - ANOVA, parametric and non parametric test; Correlation coefficient, simple linear regression, Chi-square test. **Research paper writing and publication**- layout of a research paper, impact factor of journals, h-index and i10-index, structure and content, presentation,.citing references, styles and types, Ethical issues related to publishing, software for paper formatting Plagiarism and self plagiarism, software for detection of plagiarism Thesis writing – structuring a thesis: scope, outline, methodology, analysis, discussion, summary and abstract.Proof reading: Foot noting, end noting, head noting; writing and citing references	

BIOINFORMATICS APPLICATIONS TO PROTEIN STRUCTURE LAB

COURSE OBJECTIVES: The main objective of the course is to train the students how to determine the small molecule structure

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Teaching Hours
I	1. Advanced Visualization Software and 3D representations. 2. Small Molecule Structure determination a) Structure Solution: SHELXS b) Structure Refinement: SHELXL 3. Thermal Ellipsoid Plot: a) ORTEP 4. Structure analysis a) PARST b) Platon c) Mercury 5. Comparative structure alignment and analysis using three dimensional structures of protein and nucleic acids. A) DALI 6. Structure Validation Procheck, WHATIF, VERIFY 3D 7. Exploration of CCP4 for macromolecular crystallography	

COURSE OUTCOME: Students gained the knowledge of how to solve the small molecule structure through X-ray crystallography method.

MSBJ 0971: PROJECT WORK

Credits: 16 **Semester IV** **L–T–P: 0-0-0**

Module No.	Content	Teaching Hours
I	Project work	6 months