



GLA
UNIVERSITY
MATHURA
Established vide U.P. Act 21 of 2010.

Course Curriculum (w.e.f. Session 2025-26)
Master of Science Bioinformatics (M.Sc.)



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M.Sc. (BIOINFORMATICS) COURSE CURRICULUM

(w.e.f. Session 2025-26)

INSTITUTE OF APPLIED SCIENCES & HUMANITIES

AMENDMENTS AS RECOMMENDED BY BOARD OF STUDIES

2025-26

DATE: April 19, 2025

COURSE STRUCTURE

M.Sc. (BIOINFORMATICS)

First Semester

S. NO.	CODE	SUBJECT	CORE/ELECTIVES	TEACHING SCHEME			CREDIT S	CONTACT HR/WK
				L	T	P		
1	MMAS 0501	Advanced Biostatistics	Open Elective	3	1	0	4	4
2.	MSBC 0001	Biochemistry	Core	4	0	0	4	4
3.	MSIC 0002	Cell and Molecular Biology	Core	4	0	0	4	4
4.	MSBC 0003	Fundamentals of Bioinformatics	Core	4	0	0	4	4
5.	MSBC 0004	Biophysical Techniques	Core	4	0	0	4	4
PRACTICALS								
6.	MSIC 0802	Fundamentals of Bioinformatics Lab	Core	0	0	3	2	3
7.	MSMC 0802	Biochemistry & Biophysical Techniques & Lab	Core	0	0	3	2	3
Total				19	1	6	24	26

Second Semester

S. NO.	CODE	SUBJECT	CORE/ELECTIVES	TEACHING SCHEME			CREDIT S	CONTACT HR/WK
				L	T	P		
1.	MSIC 0003	Biothermodynamics	Core	4	0	0	4	4
2	MSIC 0004	Molecular Modeling and Drug Design	Core	4	0	0	4	4
3.	MSIC 0005	Sequence analysis	Core	4	0	0	4	4
4.	MSIC 0006	Programming in Python	Core	4	0	0	4	4
5.	MSIC 0007	Cheminformatics	Open Electives	4	0	0	4	4
6		Soft skills I	Humanities	1	0	0	1	1
PRACTICALS								
7.	MSIC 0804	Programming in Python Lab	Core	0	0	3	2	3
8.	MSIC 0805	Molecular Modelling and Drug Design	Core	0	0	3	2	3
9.	MSIC 0806	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.	New Code	Data mining and big data analysis	Core	4	0	0	4	4
2.	New Code	Genomics and Proteomics	Core	4	0	0	4	4
3.	New Code	R language and Big Data Analysis	Core	4	0	0	4	4
4.	New Code	System & Structural Biology	Core	4	0	0	4	4
5	New Code	Soft skill II	Humanities	1	0	0	1	1
ELECTIVES (Select any two)								
6.	New Code	Nanobiotechnology	Elective	2	0	0	2	2
7.	New Code	Artificial Intelligence in Bioinformatics	Elective	2	0	0	2	2
8.	New Code	Clinical Research in Medicinal Plants	Elective	2	0	0	2	2
9.	New Code	Bioinformatics applications to Protein Structure	Elective	2	0	0	2	2
ELECTIVES (Select any one)								
11.	New Code	Research Methodology	Elective	2	0	0	2	2
12.	New Code	IPR, Patent, Trademarks & Bioethics	Elective	2	0	0	2	2
13.	New Code	Immuno-informatics	Elective	2	0	0	2	2
PRACTICALS								
14.	New Code	Genomics & Proteomics Lab	Core	3	0	3	2	3
15.	New Code	R language and Big Data Analysis Laboratory	Core	3	0	3	2	3
PRACTICALS BASED ON ELECTIVES (Select any two)								
16.	New Code	Artificial Intelligence in Bioinformatics Lab	Elective	2	0	2	1	2
17.	New Code	Nanobiotechnology Lab	Elective	2	0	2	1	2
18.	New Code	Clinical Research in Medicinal Plants Lab	Elective	2	0	2	1	2
19.	New Code	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.	New Code	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	14
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			96



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	<p>Numerical descriptive techniques: Measures of central tendency-mean, median, mode, Partition values-quartiles, deciles, percentiles, Measure of dispersion, Moments, Skewness, Kurtosis.</p> <p>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.</p> <p>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.</p>	18
II	<p>Sampling Theory: Objective of sampling, Sampling error, Methods of sampling, Sampling distribution, Sampling distribution of sample mean and sample proportion, Standard error.</p> <p>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.</p>	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
C01	PO2, PO3, PO5, PO8/PS01, PS02
C02	PO1, PO2, PO4/PS01
C03	PO1, PO6, PO7,PO8/PS02
C04	
C05	
C06	
C07	

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	<p><u>Carbohydrates</u> 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, regulation, 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</p> <p><u>Amino acids</u> 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</p>	18
II	<p><u>Lipids</u> 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</p> <p><u>Nucleic acids</u> 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</p>	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, “Lehninger Principles 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 Analyze*)

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

COs	POs/ PSOs
C01	PO1, P03, P04, P07/PS01, PS02
C02	PO2, P04, P05, P08/PS01, PS02
C03	PO1, P03, P05, P06, P08/PS01, PS02
C04	
C05	
C06	
C07	

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	<ul style="list-style-type: none"> Cell as a unit of living system Structure and function of different organelles: Organization of cell membrane, cytoskeleton, Endoplasmic reticulum, Golgi complex, Vesicles, Lysosomes. Nucleus, mitochondria and chloroplast, Endo-symbiotic theory Steps in cell cycle, cell cycle check points, cell division control and regulation Cell signaling: Exocrine, endocrine, paracrine and synaptic strategies of chemical signaling, surface receptor mediated transduction (DAG, Ca⁺⁺. c-AMP , G-protein) Apoptosis: phases and significance, morphological and biochemical changes associated with apoptotic cell, Oncogenesis. 	18
II	<ul style="list-style-type: none"> Structure and Functions of Nucleic Acid: Structure of DNA - evidence for DNA as genetic material, Genomic DNA structural organization DNA, RNA and Protein Synthesis – Replication, Transcription, Translation and their post-modifications, RNA processing, RNA splicing, polyadenylation, Functions of ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination. Gene regulation in eukaryotic and prokaryotic cells. Genomes: The genomes of bacteria, viruses, plasmids, and eukaryotes. 	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, Robertis and Roberties

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
C01	PO1, PO3, PO4, PO5, PO7/PS01, PS02
C02	
C03	
C04	
C05	
C06	
C07	

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), Cytoscape.	14
	Primary database, secondary database, composite database.	18
	Database similarity searching: BLAST, PSI BLAST Multiple Sequence Alignment: Star Alignment Heuristics, Applications of MSA: PSSM, Profiles, Hidden Markov Model.	
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.
- Purifying Protein for Proteomics, Richard J. Simpson, 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	<ul style="list-style-type: none"> 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, Tandem affinity purification, Gas-liquid chromatography, HPLC 	18
II	<ul style="list-style-type: none"> 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 Biochemistry and 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, Osterman Vol 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: Fiklolina 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
C01	PO2,PO4, PO5, PO7 /PS02
C02	PO1,PO4, PO6, PO7,PO8 /PS01, PS02
C03	PO1,PO4, PO5, PO8 /PS01

MSBC 0802: BIOINFORMATICS LAB

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

Credits: 02

Semester I

L-T-P: 0-0-3

Module No.	Content	Lab Hours
I	<p>Bioinformatics Resources – NCBI, EBI, ExPASy, RCSB, DDBJ</p> <ul style="list-style-type: none"> 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 visualization tool Pymol Molecular docking - Protein – Ligand Docking Mutation prediction Primer designing Data Mining 	30

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
C01	P01,P02, P04, P05, P07, P08 /PS02

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	<ul style="list-style-type: none"> • 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 V_o separation of Blue Dextran and Cobalt chloride or Protein and amino acid by Sephadex-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/ CsCl). • 	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	P02, P04, P05, P07, P08 /PS02
CO2	P01,P02, P03, P06, P08/PS01, PS02
CO3	P01, P03, P06, P07/PS01,

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 leads, aimed at discovering new candidate drugs.

Credits: 04

Semester II

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<p>Introduction to Molecular Modeling</p> <ul style="list-style-type: none"> • Concepts of Molecular modeling • Theory and Practice of Energy minimization, Monte Carlo. Definition of the potential energy surface of a molecule, force field and generic form of a force field. • Differences between molecular mechanics energy and the quantum mechanical energy of a system. • Differences between Class I, Class II and Class III force fields. • Parametrization of a force field. <p>Drug Design: Introduction to drug discovery, Current approaches and philosophies in drug design, Molecular Modelling and virtual screening techniques, lead identification, Concept of pharmacophore mapping and pharmacophore-based screening</p>	18
II	<p>Structure based drug design:- <i>De novo</i> drug design, Fragment Placements, Connection Methods, Sequential Grow, Virtual screening, HTS, Drug likeness screening, ADMET properties.</p> <p>Docking: Rigid docking, flexible docking, manual docking, docking based screening, Scoring functions, Binding energy calculations</p> <p>Molecular Dynamics simulation: Major steps, Simulation models such as coarse grained, bead rod & bead spring models, Ensembles- microcanonical, canonical, isobaric-isothermal & grand canonical ensembles</p>	24

Text Book:

1. Molecular Modelling for Beginners, Alan Hinchliffe
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.

Reference Books:

1. Advanced Concepts in Structural Bioinformatics: Structural Bioinformatics: Philip E. Bourne (Editor), Helge Weissig (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. The basic concepts of molecular modeling. (*Understand*)

CO2. Understand the *in silico* drug discovery process (*Understand*)

CO3. Understand the process of structure based drug design.

(*Understand/Apply*)

CO4. Perform the molecular docking and analyze the results. (*Apply/Analyze*)

CO5. Perform molecular dynamics simulations and interpret the parameters.

(*Apply/Analyze*)

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

COs	POs/ PSOs
CO1	P02, P04, P05, P07, P08 /PS01, PS02

MSIC 0005 SEQUENCE ANALYSIS

OBJECTIVES: To introduce to the field of genome and protein sequence analysis to extract features aimed at determining the three-dimensional structures of proteins to understand their functions.

Credits: 04

Semester II

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<ul style="list-style-type: none"> Sequence Analysis – Basic concepts of sequence similarity, Scoring matrices: Matrices for nucleic acid and proteins sequences. Sequence databases – Nucleic acid sequence databases, Protein sequence databases, Structure Databases, Sequence file formats: Various file formats for bio-molecular sequences, Protein and nucleic acid properties: Proteomics tools at the ExPASy server, EMBOSS Sequence alignment – Basic concepts of sequence alignment, Measurement of sequence similarity, Similarity and identity. Pairwise sequence alignment: Needleman and Wunsch algorithm, Smith and Waterman algorithm for pairwise alignments, gap penalties, Analysis of Nucleic acid and protein sequences and interpretation of results. 	18
II	<ul style="list-style-type: none"> Phylogenetic Analysis: Distance and Character Based Methods and Software, Computing Tools for Phylogenetic Analysis, Distances, GROWTREE, PAUP, PHYLIP and MEGA, Construction and visualization phylogenetic Tree and applications of phylogenetic analysis. Secondary Structure Analysis Tools: Sequence Motif Databases, Protein Structure Classification: GenomeNet, KEGG Databases Significance of sequence alignments: Significance of local and global alignments, Alignments with gaps, Modeling a random DNA sequence alignment 	24

Text Book:

- Bioinformatics: Andreas D. Baxevanis
- Molecular Biology by Friefelder, David

Reference Books:

- Bioinformatics: Sequence and Genome Analysis, David W Mount.

COURSE OUTCOME: After completing this course, student will able to

CO1. Understand genome sequences and the significance of their analysis. (*Understand*)

CO2. Understand the sequence databases and their file formats. (*Understand*)

CO3. Understand basic concepts of sequence alignments and their analysis in bioinformatics (*Understand / Analyze*)

CO4. Perform sequence alignments using various algorithms. (*Understand and Analyze*)

CO5- Perform phylogenetic analysis of sequences. (*Apply and Analyze*)

CO6- Analyze the sequences independently and understand the significance of sequence analysis. (*Apply/Analyze*)

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

COs	POs/ PSOs
CO1	P02, P04, P05, P07, P08 /PS01, PS02
CO2	P01, P02, P04, P05, P07, P08 /PS01, PS02

MSIC 0003 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	<p>Free energy concepts: Introduction to Thermodynamics: Energy, Energy Transfer, First Law of Thermodynamics, Entropy, Second & Third Law of Thermodynamics, Gibbs energy, governing equations for Mass, Energy and Entropy in closed and open systems, Equation of state, intensive and extensive properties</p> <p>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</p> <p>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.</p>	18
II	<p>Application of first and second law of thermodynamics to biological systems. Energy rich bonds - ATP and interconversions of nucleotide phosphates. Phosphorylation potential.</p> <p>Mitochondria Architecture, chemical activity of mitochondria, Sequence of electron carriers and sites of oxidative phosphorylation, ATP generation, heme and non- heme iron proteins</p> <p>Thermodynamic considerations- oxidation - reduction electrodes, standard electrode potential, redox couples, phosphate group transfer potential.</p> <p>Respiratory controls. Theories of oxidative phosphorylation, uncouplers and inhibitors of energy transfer. ATP synthetase complex.</p>	24

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.

MSIC 0006 PROGRAMMING IN PYTHON

OBJECTIVE: The course is designed to provide Basic knowledge of Python. Python programming is intended for bioinformaticians, who wish to use Python programming language in the field of Bioinformatics.

Credits: 04

Semester II

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<p>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</p> <p>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</p>	18
II	<p>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, importing own module as well as external modules, Programming using functions, modules and external packages</p> <p>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</p>	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.

MSIC 0007 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	<p>Cheminformatics as a theoretical chemistry discipline: definition, main concepts and areas of application.</p> <p>Representing chemical structures on computers. Molecular graphs. Connectivity tables. ChemDraw, Chems sketch 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.</p> <p>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.</p>	18

II	<p>Molecular Interaction Fields. 3D QSAR. Molecular fields' similarity</p> <p>Pharmacophore approach Pharmacophore features. Ligand- and structure-based pharmacophores. Merged and shared pharmacophores. Pharmacophore-based virtual screening</p> <p>Chemical Space concept. Graph-based chemical space: scaffolds, frameworks and R-groups. Scaffold tree approach. Descriptor-based chemical space: distance and similarity metrics.</p> <p>Data visualization: Generative Topographic Mapping. Network-like similarity graphs. Activity landscapes. Bioisosteres. Activity cliffs.</p> <p>Virtual screening workflow. Drug-likeness filters and structural alerts. Parameters of screening efficiency.</p>	24
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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 Cheminformatics Algorithms, 2010, Faulon & Bender. CRC, Amazon
3. An Introduction to Cheminformatics, 2003, Leach & Gillet. Springer, Amazon.
4. Cheminformatics: A Textbook, 2003, Gasteiger & Engel, Wiley, Amazon.

COs	POs/ PSOs
C01	PO1, PO2, PO4, PO5, PO7, PO8 /PS01, PS02
C02	PO1, PO3, PO4, PO5, PO6, PO7, PO8 /PS01, PS02

MSIC 0804 PROGRAMMING IN PYTHON LABORATORY

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	<p>Programs based on the concepts of:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Building Python Modules <input type="checkbox"/> Obtaining user Data <input type="checkbox"/> Printing desired output <p>Programs based on the concepts of:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Conditional if statements <input type="checkbox"/> Nested if statements <input type="checkbox"/> Using else if and elif <p>Programs based on the concepts of Iteration using different kinds of loops</p> <p>Usage of Data Structures</p> <ul style="list-style-type: none"> <input type="checkbox"/> Strings <input type="checkbox"/> Lists <input type="checkbox"/> Tuples <input type="checkbox"/> Sets <input type="checkbox"/> Dictionary <p>Program based on the concepts of User-defined modules and Standard Library (random, numpy, scipy, sys, Math Module, String Module, List Module).</p> <p>Program based on Input Output. Program based on exception Handling. Program based on Simple Data analysis. Program based on Pandas.</p>	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
C01	PO1, PO2, PO4 PO5, PO7, PO8 /PS01, PS02
C02	PO1, PO3, PO4, PO6, PO7, PO8 /PS01, PS02

MSIC 0806 SEQUENCE ANALYSIS LABORATORY

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

Credits: 02

Semester II

L-T-P: 0-0-3

Module No.	Content	Lab Hours
I	<p>List of experiments:</p> <ol style="list-style-type: none"> 1. Sequence Databases: NCBI ToolKit, GenBank, 2. Expasy tools 3. EMBOSS 4. Search tools against Databases: <ul style="list-style-type: none"> • BLAST • FASTA 5. Dot Plot 6. Sequence Alignment <ul style="list-style-type: none"> • Global and Local alignment methods • Multiple sequence alignment using ClustalW algorithm 7. Generation of sequence profiles using PSI-BLAST and PHI-BLAST 8. Derivation of and searching sequence patterns using Cytoscape 9. Protein motif and domain analysis using ProDom 10. Phylogentic analysis 	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 demonstration and 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

MSIC 0805 MOLECULAR MODELING AND DRUG DESIGNING LABORATORY

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	<ol style="list-style-type: none"> 1. Protein structure databases 2. Ligand structure databases 3. Molecular visualization: PyMol <ul style="list-style-type: none"> • Visualizing a molecule in different schematic representations • Identifying interacting residues (protein and ligand interactions) • Measuring distances between atoms • B-factor visualization • Image tracing and preparation 4. Molecular Docking using AutoDock 5. Binding Site Identification 6. Virtual Screening using AutoDock Vina 7. Molecular Dynamics Simulation <ul style="list-style-type: none"> • Gromacs • Protein-ligand complex MD simulation 8. Phyre2 Analysis 9. Swiss model 10. Geometry Optimization using SwissPdb Viewer 	30

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

CO1- Perform protein structure prediction

CO2- Perform protein structure visualization

CO3- Perform molecular docking using docking softwares.

CO4- Perform molecular dynamics simulation of protein-ligand complex

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

SEMESTER III

NEW CODE: 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	<p>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.</p> <p>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.</p> <p>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.</p>	18
II	<p>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</p> <p>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</p>	24

Text Book:

Data Mining Concepts and Techniques – Jiawei Han, Micheline Kamber, 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 Rosenfeld, 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	P01, P02, P03, P04, P07, P08 /PS01, PS02
CO2	P02, P03, P04, P05, P06, P07/PS01, PS02
CO3	P01, P02, P03, P04, P05, P06, P07/PS01, PS02

NEW CODE: 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.

Course Outcomes:

- CO1. To introduce the principles of genome organization, sequencing, and annotation.
- CO2. To explore computational tools for metagenomics and comparative genomics.
- CO3. To understand the techniques and applications of functional genomics.
- CO4. To examine protein structure, function, and interactions through proteomics tools.

Credits: 04

Semester III

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<p>Genomics and Metagenomics – Genome organization in prokaryotes and eukaryotes. Genome sequencing technologies: Sanger, Illumina, PacBio, Nanopore. Genome assembly, annotation, and gene prediction (ab initio & homology-based). Gene networks: lambda receptor, lac operon models. Prediction of genes, promoters, splice sites, and regulatory regions and result interpretation. Basic concepts on identification of disease genes. Applications in gut microbiome, environmental surveillance, bioremediation.</p> <p>Comparative genomics – Principles and approaches: Orthologs, paralogs, synteny, gene duplication. Genome alignment tools: BLAST, Clustal Omega, Mauve, MUMmer. Pan-genome and core genome concepts. Applications: Evolutionary studies, pathogenomics, vaccine targets. Databases: OrthoDB, EnsemblCompara, KEGG Orthology.</p>	18
II	<p>Functional genomics – Overview and significance of functional genomics. Transcriptomics (microarray, RNA-seq) and analysis pipelines. Gene knockout/knockdown techniques: RNAi, CRISPR-Cas9. Gene expression databases: GEO, ArrayExpress. Protein-DNA interactions: ChIP-seq and analysis. Application in biomarker discovery and disease mechanism studies, Gene/Protein function prediction using Machine learning tools.</p> <p>Proteomics – Introduction: Types and scope (expression, structural, functional). Protein separation methods: 2D-PAGE, chromatography, SDS-PAGE. Mass spectrometry: MALDI-TOF, ESI, LC-MS/MS. Protein databases: UniProt, PDB, Pfam, InterPro. Protein identification and quantification: Mascot, MaxQuant. Protein structure: Primary to quaternary structure. Structural bioinformatics tools: PDB, Swiss-Model, PyMOL. Protein-protein interaction databases: STRING, BioGRID. Applications in drug discovery and biomarker identification.</p>	24

MSBE 0001: NANOBIO TECHNOLOGY

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: 02

Semester III

L-T-P: 2-0-0

Module No.	Content	Teaching Hours
I	Basic biology principles and practice of micro fabrication techniques, Biological production of metal nanoparticles, macro molecular assemblies, quantum dots technology and its application Application in Biomedical and biological research	14
II	Developing drug delivery tools through nano biotechnology, nano particle based immobilization assays. Synthesis and characterization of different classes of biomedical polymers-nanoparticles Biosensors and nano biotechnology principles used in construction of micro electronic devices, sensors and macro mechanical structures and their functioning, immuno-nanotechnology	14

Text Book:

1. Subbaih Balaji, "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	P01, P02, P03, P04, P07, P08 /PS01, PS02
CO2	P02, P03, P04, P05, P06, P07/PS01, PS02
CO3	P01, P02, P03, P04, P05, P06, P07/PS01, PS02

NEW CODE: R LANGUAGE AND BIG DATA ANALYSIS

Credits: 04

Semester III

L-T-P: 4-0-0

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

Module No.	Content	Teaching Hours
I	<p>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.</p> <p>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.</p> <p>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).</p>	18
II	<p>Hypothesis testing and data handling – Hypothesis testing, Parametric and nonparametric tests, Chi-square test, t-tests, ANOVA, Correlation and regression, Principal component Analysis</p> <p>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.</p>	24

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

NEW CODE: SYSTEMS AND STRUCTURAL BIOLOGY

Credits: 04

L-T-P: 4-0-0

OBJECTIVES: To understand and apply concepts of systems biology for elucidating the functional roles of complex biological networks using computational analysis.

Module No.	Content	Teaching Hours
I	<p>Systems Biology: Understanding of Biological Systems, Measurement technologies and experimental methods, Next-generation experimental systems. Bottom-up-approach, Top-down-approach. Application areas of Systems Biology.</p> <p>Introduction to Biological Networks – Systems Biology: Emergent property, Applications in health and diseases. Microarrays and its applications in systems biology. Biological Networks: Degree distribution, Clustering coefficient</p> <p>Simulation of pathways – Metabolic network, Metabolic reconstruction, Elementary mode, Extreme pathways</p>	18
II	<p>Structure Prediction Strategies – Secondary structure prediction: Algorithms viz. Chou Fasman, Segment overlap, Mathew's correlation coefficient, Identification/assignment of secondary structural elements from the knowledge of 3-D structure of macromolecule using DSSP method</p> <p>Classification and comparison of protein 3D structures – Purpose of 3-D structure comparison and concepts; Algorithms such as VAST and DALI.</p> <p>Databases and software for Systems Biology – Introduction- databases: EMP, MetaCyc. Expression databases and other databases related to systems biology. visANT & Cell Designer.</p>	24

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.

COURSE OUTCOMES: The major outcomes of this course are:

- CO1- To understand Biological Systems Networks
- CO2- To understand the applications of systems biology in health and diseases.
- CO3- To perform simulation of biological pathways
- CO4- To apply correct protein structure prediction strategies
- CO5- To classify and compare protein 3D structures for functional annotation
- CO6- To use databases and software resources for applying systems biology in emerging areas.

NEW CODE: 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: 02

Semester III

L-T-P: 2-0-0

Module No.	Content	Teaching Hours
I	Artificial Intelligence (AI) Introduction: Definition, Challenges and Applications. Role of AI in bioinformatics. Evolutionary / Phylogenetic Analysis: Overview of Phylogenetic Tree analysis. Cladistics, Phenetics and Distances. Various tree types. Overview of Bootstrapping. Tools – Clustal Omega, PHYLIP and Mega. Problems and errors in phylogenetic reconstruction.	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.

NEW CODE: 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: 02

Semester III

L-T-P: 2-0-0

Module No.	Content	Teaching Hours
I	<p>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</p> <p>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.</p>	14
II	<p>An overview of selected medicinal plants: Morphology, family, vernacular, botanical name, useful part, uses active principles and phytotherapeutics.</p> <p>Whole plant (<i>Phyllanthus amarus</i>, <i>Bacopa monnieri</i>, <i>Scoparia dulcis</i>)</p> <p>Root (<i>Asparagus racemosus</i>, <i>Rauwolfia serpentina</i> & <i>Gloriosa superba</i>)</p> <p>Leaf (<i>Aloe vera</i>, <i>Azadirachta indica</i>)</p> <p>Bulb(<i>Allium cepa</i>, <i>Allim sativum</i>)</p> <p>Rhizome(<i>Zingiber officinale</i>, <i>Curcuma longa</i>)</p> <p>Fruit (<i>Solanum nigrum</i>, <i>Solanum xanthocarpum</i>, <i>Phyllanthus emblica</i>)</p> <p>Seed(<i>Trigonella foenum graceum</i>.<i>Cuminum cyminum</i>)</p> <p>Oil seed (<i>Cocos nucifera</i>, <i>Ricinus communis</i>)</p> <p>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.</p>	14

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

- CO1. To do the sequence analysis and phylogenetic prediction with their own knowledge.
- CO2. Also capable to search the protein/gene sequence and structural information from the any biological databases.
- CO3. Helps to ensure the comparative sequence analysis without any error.
- CO4. 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) Pharmacognocoy- 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.

NEW CODE: BIOINFORMATICS APPLICATIONS TO PROTEIN STRUCTURE

The main objectives of this course are to:

- CO1. Make students understand the protein folding problem
- CO2. Apply protein primary sequence structure for predicting secondary structures.
- CO3. Train students for energy minimizing protein structures
- CO4. Train students for performing molecular dynamics simulation studies.

Credits: 02

Semester III

L-T-P: 2-0-0

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.	14
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

NEW CODE: IMMUNOINFORMATICS

OBJECTIVES:

The main objectives of this course are to:

- CO1. Make the students understand the immune system, its components and their functions.
- CO2. Provide fundamental knowledge in Immunoinformatics databases and tools.
- CO3. Learn the informatics-based approaches for prediction of Epitopes, design of vaccines and Immuno-diagnostic tools.
- CO4. Interpret the Methods to predict MHC and B-cell epitopes
- CO5. Knowledge on different tools and servers for vaccine designing.
- CO6. Explain the role of the immune molecules in infectious diseases and cancer

Credits: 02

Semester III

L-T-P: 2-0-0

Module No.	Content	Teaching Hours
I	<p>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, MHC peptide 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.</p> <p>Rational vaccine design, Reverse vaccinology, Prediction of immunogenicity - Pipeline & workflows, Toxoid as vaccine, Conjugate vaccine, DNA vaccine, Recombinant vector vaccines, Personalised vaccination.</p> <p>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.</p>	14

II	<p>Cancer Immunology: Malignant transformation of cells, Oncogenes and cancer induction, Tumors of immune system, Tumor antigens, Tumor evasion of the immune system, Cancer immunotherapy.</p> <p>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.</p> <p>Emerging and Re-emerging Infectious Diseases – Pathogens with antigenic variation, Modifying and Improving Biological Therapeutics, Computational Immunology.</p>	14
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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.

NEW CODE: 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	<p>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.</p> <p>Biosafety- Introduction to Biosafety, Definition and objectives of biosafety guidelines. Risk Assessment- Assessment of risk during laboratory research, Risk Assessment of Biotechnology products. Risk regulation. Containment- Physical containment, Biological containment.</p>	14
II	<p>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.</p> <p>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.</p>	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: 0750694440, 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
C01	PO1,PO3, PO5, PO7, PO8 /PSO1, PSO2

MSBE 0801: NANOBIO TECHNOLOGY LAB

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

Credits: 1

Semester III

L-T-P: 0-0-2

Module No.	Content	Lab Hours
I	<ul style="list-style-type: none"> 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 Iron oxide nanoparticles and its characterization Antibacterial activity of Gold Nano Particles 	20

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
C01	PO1,PO3, PO5, PO7, PO8 /PS01, PS02
C02	PO1,PO2, PO3, PO5, PO7, PO8 /PS01
C03	PO1,PO4, PO6, PO7, PO8 /PS01, PS02

MSBE 0803: CLINICAL RESEARCH IN MEDICINAL PLANTS LAB

OBJECTIVES: To understand the commercial values of medicinal plants

Credits: 01

Semester III

L-T-P: 0-0-2

Module No.	Content	Lab Hours
I	<ul style="list-style-type: none"> • 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 	20

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
C01	P01,P02, P03, P05, P06, P08 /PS01, PS02

NEW CODE: R LANGUAGE AND BIG DATA ANALYSIS LABORATORY

Credits: 02

Semester III

L-T-P: 0-0-3

Module No.	Content	Lab Hours
I	<ol style="list-style-type: none"> 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. 	30

NEW CODE:

GENOMICS & PROTEOMICS LAB

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

COURSE OUTCOMES: The major outcomes of this course are:

Course Outcome: After completing this course, students will be able to

CO1: To gain practical skills in handling and analyzing genomic and proteomic data.

CO2: Practical and theoretical skills concerning different databases.

CO3: Ability to discuss and evaluate when and how these methods are best put into use.

Credits: 02

Semester III

L-T-P: 0-0-3

Module No.	Content	Lab Hours
I	<ol style="list-style-type: none"> Genotype Analysis using Basic Biostatistics Tools – Application of Chi-square test and Odds Ratio. Introduction to Structural Bioinformatics Tools – Exploring protein data using PDB, SWISS-MODEL, and PyMOL. Comparative Genomics Analysis – Using BLAST, Clustal Omega, Mauve, and OrthoFinder for genome comparisons. Gene Expression Analysis – RNA-seq data processing and prediction of microRNAs. Phylogenetic Analysis – Construction and interpretation of phylogenetic trees using MEGA. Genome Annotation and SNP Analysis – Annotation with RAST or Prokka, and identification of SNPs. Microarray Data Analysis – Workflow for analyzing gene expression using microarray datasets. Protein Structure Visualization – Visualizing and analyzing 3D protein structures using PyMOL or UCSF Chimera. Protein Structure Quality Assessment – Generating and interpreting Ramachandran plots using PROCHECK. Proteomics Data Analysis – Identification and interaction analysis using Mascot and STRING. Protein Structure Prediction – Homology modeling using SWISS-MODEL or deep learning-based prediction with AlphaFold. Biological Network and Pathway Analysis – Analyzing metabolic and signaling pathways using KEGG. 	30

NEW CODE: R LANGUAGE LABORATORY

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 <code>install.packages()</code> 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 <code>cbind()</code> and <code>rbind()</code> 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.	20

COURSE OUTCOMES

- CO1. Setup R Programming Environment.
- CO2. Understand and use R – Data types.
- CO3. Understand and use R – Data Structures.
- CO4. Develop programming logic using R – Packages.
- CO5. Analyze data sets using R – programming capabilities

NEW CODE: ARTIFICIAL INTELLIGENCE IN BIOINFORMATICS LABORATORY

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	20

COURSE OUTCOMES

- 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

NEW CODE: 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: 02

Semester III

L-T-P: 0-0-2

Module No.	Content	Teaching Hours
I	<p>Research, concept, objectives, types (qualitative and quantitative), basis of scientific research. Research problems – Criteria for selecting a problem, choosing a methodology.</p> <p>Literature review – process, journals, books, patents and proceedings</p> <p>Research Ethics and Integrity</p> <p>Research Design: Concepts, importance, types, experimental design (Randomized, Randomized block and factorial design).</p> <p>Measurement- concept, problems and levels.</p> <p>Application of probability - variables, normal and binomial distribution; Sampling- types, size, mean and variance of a sample</p> <p>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.</p> <p>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</p> <p>Plagiarism and self plagiarism, software for detection of plagiarism</p> <p>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</p>	20

NEW CODE: BIOINFORMATICS APPLICATIONS TO PROTEIN STRUCTURE LABORATORY

COURSE OBJECTIVES: The main objective of the course is to train the students how to determine the small protein 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 by Procheck, WHATIF, 7. Protein Structure Validation tool: VERIFY 3D 8. Exploration of CCP4 for macromolecular crystallography	20

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