ALAGAPPA UNIVERSITY

(A State University Established in 1985)
Karaikudi - 630003, Tamil Nadu, India

2017 — Accredited with A+ Grade by NAAC (CGPA : 3.64)

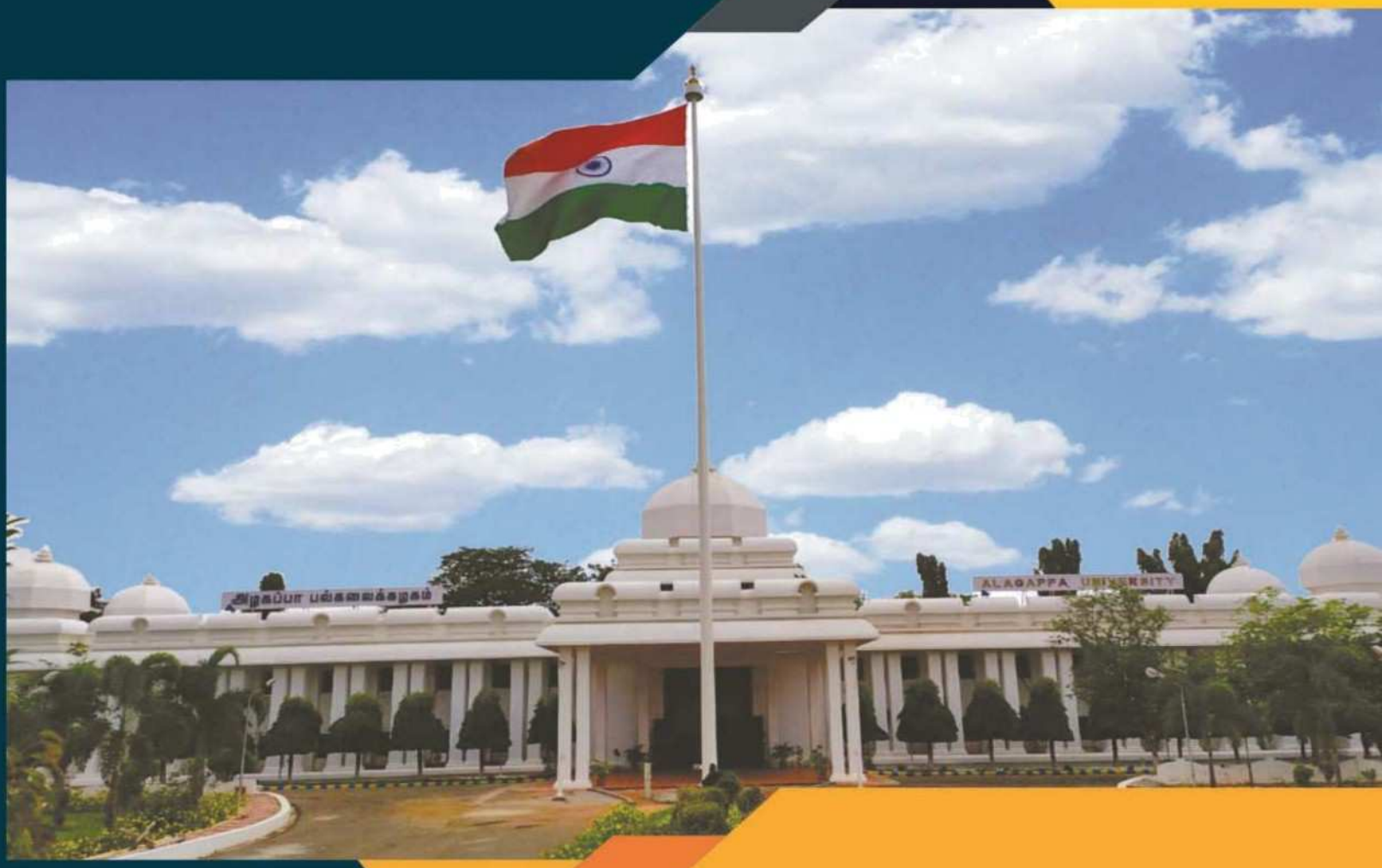
2018 — Graded as Category - 1 & Granted Autonomy

2018 — MHRD Swachh Campus Rank : 4

2019 — NIRF National Institutional Ranking Framework Rank : 28

2019 — QS India Rank : 29, BRICS Rank : 104, Asia Rank : 216

DEPARTMENT OF BIOINFORMATICS



M.Sc., BIOINFORMATICS

[Choice Based Credit System (CBCS)]

[For the candidates admitted from the academic year 2019-**2020**]

ALAGAPPA UNIVERSITY

(AStateUniversityAccreditedwith"A+"gradebyNAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC)

M.Sc BIOINFORMATICS

(For those who join the Course in July 2019 and after)

REGULATIONS AND SYLLABUS

REGULATIONS

1. Eligibility

Candidates for admission to Master of Science in Bioinformatics shall be required to have passed B.Sc., (Bioinformatics/ Biotechnology/ Microbiology/ Biochemistry/ Botany/ Zoology/ Physics/ Chemistry) / B.Sc. (Agri.) / B.V.Sc., /B.Pharm.,/ B.E./B.Tech.,(Biotech/Bioinformatics)/MBBS or any other course equivalent thereto and must have obtained 55% marks at graduation level.

2. Duration of the Course

The course shall extend over a period of two years under Semester Pattern accounting to four semesters.

3. Standards of Passing and award of Division.

a) The minimum marks for passing in each theory / lab course shall be 50% of the marks prescribed for the paper / lab.

b) A candidate who secures 50% or more marks but less than 60% of the aggregate marks prescribed for four semesters taken together, shall be awarded **SECOND CLASS.**

c) A candidates who secures 60% or more of the aggregate marks prescribed for four semesters taken together, shall be awarded **FIRST CLASS.**

d) The practical / project shall be assessed by the two examiners, appointed by the University.

4. Number of candidates to be admitted

The maximum number of students to be admitted for the Master's Programme in an academic is up to 20.

5. Admission

Admission shall be based on merit basis in accordance with the number of applications received / entrance examination conducted on the following criteria:

i)	Entrance Examination Question Paper shall be in the following pattern		
a)	No. of Questions to be covered from Physical/Life Sciences at + 2 level	:	50 (compulsory)
b)	No of Questions to be covered from Physical Sciences at Degree level	:	25 (compulsory)
c)	No of Questions to be covered from Life Sciences at Degree level or No of Questions to be covered from Mathematics at Degree level	:	25 (optional)
ii)	A candidate may answer a maximum of 100 questions		
iii)	Duration of Examination shall be two hours		
iv)	Tamil Nadu Govt./University norms may be followed for selection		

6. Examination Question Pattern

Theory Courses: **Max: 75 Marks**

Part – A

Ten questions (No choice) 10 x 2 = 20 marks
(Two questions from each Unit)

Part – B

Five questions (either or type) 5 x 5 = 25 marks
(One question from each Unit)

Part – C

Three questions out of five 3 x 10 = 30 marks

Practical Viva-voce

7. Grading System of the University

Marks	Grade Point	CGPA	Grade	Description
96 and above	10	9.51 and above	S+	First Class - Exemplary
91-95	9.5	9.01-9.50	S	
86-90	9.0	8.51-9.00	D++	First Class - Distinction
81-85	8.5	8.01-8.50	D+	
76-80	8.0	7.51-8.00	D	
71-75	7.5	7.01-7.50	A++	First Class
66-70	7.0	6.51-7.00	A+	
61-65	6.5	6.01-6.50	A	
56-60	6.0	5.51-6.00	B	Second Class
50-55	5.5	5.00-5.50	C	
Below 50		Below 5.00	RA	Re-appear
			AA	Absent

8. Attendance

The candidate should have earned attendance of 75% and above during the period for appearing the examination. Candidates who have earned 70% to 74% of attendance have to apply for condonation in the AU prescribed form with the prescribed fee of Rs.100/- per subject and who have earned 60% to 69%, Rs.150/- per subject along with the medical certificate. Candidates who have attended below 60% are not eligible to appear for the examination.

9. Fee structure

The following shall be the fee structure for the M. Sc programme

1st Year	Tuition Fee	:	Rs. 3000/-	Total Rs. **10,000/-**
	Computer, Special and Other Fees	:	Rs. 7000/-	
2nd Year	Tuition Fee	:	Rs. 3000/-	Total Rs. **9,000/-**
	Computer, Special and Other Fees	:	Rs. 6000/-	

For Foreign Nationals opting for M.Sc programme the fees is**USD $ 250**

Special and other fees shall be as prescribed by the University

10. General Objectives of the Program

The general objective of the M.Sc program in Bioinformatics is to develop strong-minded graduates with high-quality skills in the field of Structural Bioinformatics and Computer Aided Drug Design. The curriculum designed is to assist the students in understanding the vital concept of fundamentals involved in the structure determination through various Molecular Biology, Biochemical and Cell Biology experimental methods with practical hands-on training in the usage of Bioinformatics tools for Drug Discovery. At the end of the program, the student will gain in-depth knowledge in Bioinformatics and play an active role in biological research, government or non-government organization, and private sectors.

11. Specific Objectives of the Program

i. To train the students in various Molecular Biology experimental methods that aids the students to perform related Structural Biology techniques (Cloning, Expression, Purification & Crystallization) to isolate the protein of interest skillfully through laboratory practical.

ii. To emphasize on the flexibility of the state of the art technologies available especially in the area of Computer Aided Drug Design (CADD) and provide lab training to know how to manage the generated Biological data.

iii. To address the challenges arising from the huge amount of genomic data and to overcome by analyzing and individualizing the corresponding drug responses towards appropriate drug specified dosages.

iv. To create user-friendly tools and databases with the help of programming languages and algorithms. Additionally, two journal clubs in a month/ annual national conference/ weekly career guidance(s) are conducted that would help them know about the recent advances in the subject and also develop their knowledge accordingly.

12. Outcomes of the Program

i. To work with confidence and conscience in Fundamentals of Biological problem for instance to identify the structural and functional aspects of small and macromolecule in a typical biological laboratory and also to be aware of contamination issues.

ii. To identify suitable leads against targets responsible towards disease onset and progression that provides a regimen for drug discovery and development proves. Exclusively, at the end of the program the graduates are molded as finer competent against the thriving competition from the students of premier institutes of India.

iii. To understand the concepts and specific features of the subject that is further perceived as application across the disciplines of Computational and Biosciences. In addition to have established knowledge in scientific writing, on how to give a scientific presentation, how to evaluate a scientific paper, and research ethics and as well as to apply their learned skills in the techniques within the chosen area of research.

iv. To fulfill needs of the industry for the manpower with the specific skills sets related to Bioinformatics.

13. Choice Based Credit System (CBCS) for those who join in July 2019 or after

EC- Extra Credit; **I**-Internal Marks, **E**-External Marks

S. No.	Course		Subject Code	Credit	Hrs	Marks		
						I	E	Total
SEMESTER-I								
1	**Core I**	Introduction to Bioinformatics	502101	5	5	25	75	100
2	**Core II**	Biochemistry and Molecular Cell Biology	502102	5	5	25	75	100
3	**Core III**	Mathematics and Statistics for Biologists	502103	5	5	25	75	100
4	**Core IV**	Lab-I: DBMS and MYSQL	502104	4	8	25	75	100
5	**Elective I**	Major Elective-I		5	5	25	75	100
	Library/ Journal club/Career Guidance				2			
Total				**24**	**30**			**500**
SEMESTER-II								
6	**Core V**	Phylogeny and Phylogenomics	502201	4	4	25	75	100
7	**Core VI**	Molecular Modeling and Drug Design	502202	5	5	25	75	100
8	**Core VII**	Computational Biology	502203	5	5	25	75	100
9	**Core VIII**	Programming in Scripting Languages (PYTHON, PERL & R)	502204	5	5	25	75	100
10	**Core IX**	Lab-II: Molecular Biology and Biochemical techniques	502205	3	6	25	75	100
11	**Non Major Elective (NME) - I**			2	3	25	75	100
12	**Self Learning course (SLC) - I**		MOOC's	EC				
	Library/Yoga/Journal club/Career Guidance				2			
Total				**24+EC**	**30**			**600**
SEMESTER-III								
13	**Core X**	Genetics and Genetic Engineering	502301	4	4	25	75	100
14	**Core XI**	Structural Biology	502302	5	5	25	75	100
15	**Core XII**	Pharmacogenomics	502303	4	4	25	75	100
16	**Core XIII**	Lab-III: Computer Aided Drug Design (CADD)	502304	4	8	25	75	100
17	**Non Major Elective (NME) - II**			2	3	25	75	100
18	**Elective II**	Major Elective-II		5	5	25	75	100
19	**Self Learning course (SLC) - II**		MOOC's	EC				
	Library/Yoga/Journal club/Career Guidance/ Employability skills				1			
Total				**24+EC**	**30**			**600**
SEMESTER-IV								
20	**Core XIV**	Machine Learning and Artificial Intelligence	502401	3	3	25	75	100
21	**Core XV**	Systems Biology	502402	3	3	25	75	100
22	**Core XVI**	Lab-IV: Small and Macromolecular Crystallography	502403	4	8	25	75	100
23	**Core XVII**	Project Work & Viva-Voce	502999	8	16	25	75	100
	Library/ Journal club/Career Guidance							
Total				**18**	**30**			**400**
Grand Total (Semester I + II + III + IV)				**90+EC**	**120**			**2100**

Semester wise credit details:

I	Semester	24 Credits	Core Credits: 19; Major Elective Credits: 5
II	Semester	24 Credits + EC	Core Credits: 22; Non-Major Elective Credits: 2; Self Learning course credits - EC
III	Semester	24 credits+ EC	Core Credits: 17; Major Elective Credits: 5; Non-Major Elective: 2; Self Learning course credits - EC
IV	Semester	18 credits	Core Credits: 10; Project Work& Viva-Voce: 8
Total credits		**90+ EC**	**Core Credits: 58; Major Elective Credits: 10; Non-Major Elective Credits: 4; Project Work & Viva-Voce: 8 + Self Learning course credits - extra credits**

Major Elective for the Department of Bioinformatics		
S. No	**Subject Code**	**Subject Name**
1.	502501	General Chemistry
2.	502502	Fundamentals of Computing
3.	502503	IPR, Bio-safety and Bioethics
4.	502504	Biosensor
5.	502505	Molecular Interactions
6.	502506	Introduction to Neural Networks
7.	502507	Data Warehousing and Data Mining
8.	502508	Programming in C and C++
9.	502509	Cell communication and Cell signaling
10.	502510	Big data analysis and Next Generation Sequencing
11.	502511	General Microbiology
12.	502512	Open Source in Bioinformatics
13.	502513	Biodiversity, Agriculture, Ecosystem, Environment and Medicine
Non Major Elective for the Department of Bioinformatics		
14.	533704	Nanotechnology and Advanced Drug Delivery System
15.	509203	Immunology and Immuno technology

Non Major Electives for the other Departments

S. No	**Subject Code**	**Subject Name**
1.	502101	Introduction to Bioinformatics
2.	502202	Molecular Modeling and Drug Design
3.	502203	Computational Biology
4.	502204	Programming in Scripting Languages (PYTHON, PERL& R)
5.	502302	Structural Biology
6.	502303	Pharmacogenomics

REQUIRED FACILITIES FOR THE PROGRAMME

I. For Wet Lab Facility:

Basic minor instruments

Thermocycler

-86°C ultra freezer

-20°C deep freezer

Walk-in cold room storage

Ultra Water Purification

Stackable Orbital Shaking Incubator

Ultra centrifuge

Ice flaks maker

Ultra sonicator

Refrigerated centrifuge

Next Generation Sequencer

FPLC - Protein Purification system

Multi Plate Reader

Nano Spectrophotometer

Kinetic biospectrometer

Upright Polaroid Microscope

Small Angle X-ray Scattering

2-D Electrophoresis

Biacore

Isothermal Titration Calorimetry

Nano LC - MS/MS

Small and Macromolecule X-ray Diffractometer

II. For Computational Lab:

IBM Super computer

High Performance Cluster Computers

High Performance Workstations -50

Desktop Computers – 50

UPS power backup

III.Softwares

Schrodinger software commercial package

Gromacs

Amber

Gaussian

Cambridge Structural Database

Semester - I			
Course Code: 502101	**Introduction to Bioinformatics**	**Credits: 5**	**Hours :4**
Objectives	➢ To make students understand the essential features of the interdisciplinary field of science for better understanding biological data. ➢ To provide the student with a strong foundation for performing further research in bioinformatics. ➢ To create students opportunity to interact with algorithms, tools and data in current scenario.		
Unit - I	**Basics of Bioinformatics:** Introduction to Bioinformatics; Computers in Biology to understand Biological System; Basic commands of Windows, Unix and Linux operating systems; Concept of open resources in Bioinformatics.		
Unit - II	**Sequence Analysis:** Biological background for sequence analysis; Sequence alignment: Global, Local, Pairwise and Multiple sequence analysis; Algorithm for alignments; Database Searching; Tools for Sequence alignment.		
Unit - III	**Biological Databases**: Database concepts; Introduction to Data types and source; Protein Sequence and Structural Databases; Nucleic acid databases; Genome databases; Specialized Databases; Carbohydrate Databases; Clinically relevant drug-drug interactions databases; Information retrieval from Biological databases: Entrez system, TCGA data bases, Bioportal		
Unit - IV	**Cheminformatics:** Introduction; Cheminformatics tools; Chemical structure representation (SMILES and SMARTS); Chemical Databases: CSD, ACD, WDI, Chembank, PUBCHEM, Chemical Structure file formats; Structural Isomers; Structure visualization.		
Unit-V	**Medical and Pharmacy Informatics:** Introduction to pharmacy informatics, Medical Transcription, Role of informatics to enhance the services provided by pharmaceutical care givers. Health Information Systems Architecture, Health Data Management, Medical Coding, Telemedicine and Telehealth, Ethics in medical informatics, Pharmacy systems and automation, Informatics applications in pharmacy, survey and evaluation of on-line resources.		
Reference and Textbooks:-			
Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K.& Watson, JD. (1991). *Molecular Biology of the cell.* Oxford (3rd ed.).Garland publishers. De Robertis, E. D., & De Robertis, E. M. (1987). *Cell and molecular biology*. Lea & Febiger. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2004). *Overhead Transparency Set for Lehninger Principles of Biochemistry (4th ed.).* WH Freeman. Murray, R. K., Granner, D. K., Mayes, P. A.,& Rodwell, V. W., (2006). *Harper's Biochemistry(27th* ed.). McGraw Hill.			
Outcomes	➢ The student should be able to understand basic research methods in bioinformatics. ➢ The student will choose biological data, submission and retrieval it from databases and design databases to store the information. ➢ The students will be able to demonstrate the most important bioinformatics databases, perform text- and sequence-based searches, and analyze the results in light of molecular biological knowledge		

Name of the Course Teacher: Dr. J. Joseph Sahayarayan &

Dr. Sanjeev Kumar Singh

Semester – I			
Course Code: 502102	**Biochemistry and Molecular Cell Biology**	**Credits:5**	**Hours: 9**
Objectives	➢ Identify and define different types of biomolecules and the important structural features of biomolecules. ➢ Classify carbohydrates, proteins, lipids and vitamins on the basis of their structure & functions. ➢ Give the composition of proteins and nucleic acids and explain the difference between DNA and RNA.		
Unit – I	**Structure, Functions and Classifications of Biomolecules:** Classification, structural organization of proteins - Primary, secondary, tertiary and quaternary structures, forces stabilizing the structure, properties of proteins. Carbohydrates: Introduction and general classification of carbohydrates. Structures, properties and biological functions of monosaccharides. Classification, structure and properties of lipids. Introduction, structure of nitrogenous bases - purines and pyrimidines, nucleosides, nucleotides, formation of phosphodiester bonds. Structure, types, properties, functions of DNA and RNA. Introduction, structures, sources, RDA, functions, deficiency diseases of fat soluble and water soluble vitamins.		
Unit – II	**Cellular Components and their functions:** Basic aspects of Prokaryotic and eukaryotic cells (plant and animal cells). Dynamics of the eukaryotic cell- Molecules of life- Cellular evolution assembly of macromolecules and Origin of life- integrated structural organization of prokaryotic and eukaryotic cells- Concept of a composite cell and Molecular composition of cells. Biomembranes- Structural organization- Models of a plasma membrane, Membrane permeability- Transport across cell membranes- Transmembrane signals- Artificial membranes- liposome. Prokaryotic and Eukaryotic genome organization and structure, mechanisms of gene expression in Prokaryotes and Eukaryotes, factors involved in gene regulation.		
Unit – III	**Cell cycle and cell division:** Cell cycle - Different stages of mitosis – significance of meiosis - Cohesins and condensins in chromosome segregation, Microtubules in spindle assembly, Structure of kinetoshore, centrosomes and its functions, Components in cell cycle control - Cyclin, CDKs, Check points in cell cycle, phase dependent cyclic CDK complexes Cell cycle and its regulation, events during mitosis and meiosis.		
Unit – IV	**Concepts of Gene and Mutations:** Basic concepts of replication, Regulation of translation, Post transcriptional modifications, processing of DNA, RNA and proteins methods for studying gene expression and regulatory sequences, Recombinant DNA technology, overexpression. Mechanisms of genome alterations: Recombination, mutation, inversion, duplication, transposition. Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance. Concepts of gene: Allele, multiple alleles, pseudoallele, complementation tests. Mendelian principles: Inheritance, sex linked inheritance, Dominance, segregation, independent assortment. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.		
Unit-V	**Gene Transfer methods and Population studies:** Genetic variations and polymorphism at genome level, Epigenetic mechanisms of inheritance, Methods of genetic transfers – transformation, conjugation, transduction and sexduction, mapping genes by interrupted mating, fine structure analysis of genes. Basic Human genetics: Pedigree analysis, linkage testing, karyotypes, genetic disorders, Population genetics, Hardy Weinberg Principle.		

<table>
<tr><td colspan="2">Reference and Textbooks:-
Alberts, B. (2014). The Molecular Biology of The Cell (6th ed.). Garland Science Publisher.
Alberts, B., Bray, D., lewis, J., Raff, M., Roberts, K., Hopkin, K.,& Johnson, A. (2014). Essential Cell Biology (4th ed.). Garland Science Publisher.
Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K.& Watson, JD. (1991). Molecular Biology of the cell (3rd ed.). Oxford.Garland publishers.
Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2004). Overhead Transparency Set for Lehninger Principles of Biochemistry (4th ed.). WH Freeman.
Watson, J.D., Levine, M., Losick, R., Gann, A.,& Bell, S.P. (2013). "Molecular Biology of the Gene (7th ed.). Pearson Educational Limited.</td></tr>
<tr><td>Outcomes</td><td>The students shall be able to:
➢ Understand the principles, concepts and facts of the structure and their related functions of proteins.
➢ Recognize the structure and properties of simple carbohydrates, oligosaccharides and polysaccharides.
➢ To understand the structure properties and biological functions of lipids and biological membranes.</td></tr>
</table>

Name of the Course Teacher: Dr. J. Joseph Sahayarayan,

Dr. V.K. Langeswaran &

Dr. P. Boomi

Semester - I			
Course Code: 502103	**Mathematics and Statistics for Biologists**	**Credits: 5**	**Hours :5**

Objectives	➢ For better integration of the concepts at the intercepts of mathematical methods and biological codes, sequences, structures, networks, and systems biology. ➢ Understand and apply statistical techniques that are essential to process and interpret biological data.
Unit - I	**Trigonometry, Vector Analysis, Calculus and Matrices**: Trigonometric Functions, Series Expansion, Inverse, General Values, Graphs, Calculus: Limits, Analysis, Definite Integrals, Vector Algebra, Vector Calculus, Basic Computations, Matrices. Measure Theory: Introductory Concepts, Borel Sets, Lebesgue Integration, Complex Variable: Complex Functions, De Moivre's Theorem, Conformal Map, Complex Integration, Numerical Techniques: Basic Formalism, Methods for Solving Equations, Finding Eigen values & Eigen vectors, Solving ODE & PDE, Differentiation and Integration.
Unit - II	**Data Representation:** Types of numerical data, Tables and Graphs. Measures of central tendency: Arithmetic Mean, Weighted arithmetic mean, Median and Mode - Geometric mean and Harmonic mean. Measures of dispersion**:** Range, Inter-quartile range, Average deviation, Standard deviation and Coefficient of variation, Lorenz curve. **Theory of Sampling:** The purpose of sampling, Principles of sampling, Methods of samplings, Techniques of non-probability sampling, Size of Sample, Sampling and Non-Sampling errors.
Unit - III	**Distributions:** Expected value and Variance Normal Binomial distribution, Poisson distribution, Normal distribution, Chi square test, Students 't' test . Testing of hypothesis: Type I and Type II errors, power of a test, p value. **Set theory and Probability:** Roaster and Set builder form; De morgans' Law, Limits: Constants, Types of constants, variables, function, right and left hand limits. Concept of probability, Sample space, Independent events, mutually exclusive events, Addition law of probability, Conditional probability, Central limit theorem, Bayes theorem, Markov chains, their transition probability and stationary distributions.
Unit - IV	**Correlation and Regression:** Types of Correlation, Methods of studying Correlation: Scatter diagram, Karl Pearson's Coefficient of Correlation, Spearman's Rank Correlation.
Unit-V	**Biostatistics**: Application of statistics to biology, sample size and power analysis, hypothesis testing, confidence intervals, regression, ANOVA, Computer software package for statistical analysis including R, SAS, and PRISM packages. **R programming for Biostatistics:** Basic statistics in R, correlation and covariance, T-test, ANOVA and probability distributions.

Reference and Textbooks:-

Gurumani,N. (2015). *An Introduction to Biostatistics (*2nd ed.*)*. MJP Publisher.

Isaev, A. (2006). *Introduction to mathematical methods in bioinformatics*. Springer Science & Business Media.

Lander, P. (2017). *R for Everyone: Advanced Analytics and Graphics (*2nd ed.). Pearson.

Norman, M. (2001). *The Art of R Programming – A Tour of Statistical Software Design.* Cengage Learning.

Segal, L. (1980). *Mathematical Models in Molecular and Cellular Biology*, Cambridge: Cambridge University Press.

Zar, J.H. (1984). *Bio Statistical Methods*. USA: Prentice Hall International Edition.

Outcomes	➢ The student able to formulate as well as analyze mathematical and statistical problems, precisely define the key terms, and draw clear and reasonable conclusions. ➢ Biostatistics is essential to ensure that the knowledge has been incorporated in places such as public health sector and biomedicine to henceforth bring viable solutions that could ease the complexity of biological problems.

Name of the Course Teacher: Dr. J. Jeyakanthan &Dr. M. Karthikeyan

SEMESTER-I			
Course Code: 502104	**Lab-I -Database Management System and MYSQL**	**Credits:4**	**Hours:8**
Objectives	➢ To give a good formal foundation on the relational model of data. ➢ To present SQL and procedural interfaces to SQL comprehensively.		
Unit-I	**Introduction to DBMS**: Introduction to Databases, DBMS Definition, Characteristics of DBMS, Application and advantages of DBMS, Instances, Schemas and Database States, Three Levels of Architecture, Data Independence, DBMS languages, Data Dictionary, Database Users, Data Administrators.		
Unit-II	**Data Models in DBMS:** Entity Relationship Model, Entity Types, Entity Sets, Attributes and its types, Keys, E-R Diagram, Data Integrity RDBMS –Concept, Components and Codd's rules. **Relational Database Model:** Logical view of data, keys, integrity rules, Relational Database Design: features of good relational database design, atomic domain and Normalization (1NF, 2NF, 3NF, BCNF).		
Unit-III	**Open Source Database Software:** Features of MySQL data types: Numeric, date & time, string, Table creation in MySQL: insert, delete, update, select, where clause, ordering the result, like operator Selecting Multiple tables: using join, using queries Modifying records: update command, replace command, delete command date & time functions in MySQL.		
Unit-IV	**Introduction to MySQL:** Basic Linux commands, About Linux, Linux Command, Command Types, Installing MySQL: MySQL Installation, Windows Installation, Linux RPM Installation, Linux Binary Installation, Source Installation, Starting and stopping MySQL: Four different methods to start MySQL in Linux, MySQL Stopping, Basic MySQL Queries: DML Queries, DDL Queries, TCL Queries, Types of Joins, Unions, Various logs in MySQL and its uses: MySQL Logs, Error Log, Query Log, Slow Query Log, Binlog and its format, Relay Log.		
Unit-V	**Mysql Admin Commands**: MySQL Admin Commands, Workbench MySQL, Locking in MySQL: Locking in MySQL, Internal Locking, Table level Locking, Row level Locking, External Locking, Dead Lock, MySQL client Programs, MySQL Table maintenance: Table Maintenance, Analyze Table, Backup Table, Check Table, Checksum Table, Optimize Table, Repair Table, Restore Table, Moving Tablespace, Information Schema and Performance Schema: MySQL Information schema, Tables in Information schema, MySQL Performance schema.		

Reference and Text Books:-

Coronel, C., Morris, S., & Rob, P. (2013). Database Systems: Design, implementation, and Management, Cengage Learning. *ISBN-10*, *1285099672*.

Date, C.J. (2000). *An introduction to Database systems*. Addison Wesley Publishers.

Delisle, M. (2006). *Creating your MySQL Database: Practical Design Tips and Techniques*. Packt Publishing Ltd.

Elmasri, R., & Navathe, S. B. (2011). *Database systems* (Vol. 9). Boston, MA: Pearson Education.

Paul Du Bois, (2003). *MySQL Cookbook.* Sams Publishing.

Raghu, R., & Johannes, G. (2003). *Database Management System.* McGraw-Hill Education.

Silberschatz, A., Korth, H. F., & Sudarshan, S. (2010). *Database system concepts*. New York:

<table>
<tr><td colspan="2">McGraw-Hill.
Vaswani, V. (2017). MySQL: The complete reference. McGraw-Hill Osborne Media.
Welling, L., & Thomson, L. (2003). MySql tutorial. Sams Publishing.</td></tr>
<tr><td>Outcomes</td><td>➢ Understand the services provided by a Database Management System. Database Administrators, Database Application Developers, Database Specialists, and DBMS developers.
➢ Identify the methodology of conceptual modeling through Entity Relationship model.</td></tr>
</table>

Name of the Course Teacher: Dr. RM. Vidhyavathi

Semester - II			
Course Code: 502201	**Phylogeny and Phylogenomics**	**Credits: 5**	**Hours: 4**
Objectives	➢ To understand concepts of molecular evolution and the nature of data for deriving molecular phylogeny ➢ To learn and apply the statistical approaches and models for Phylogenetic analysis and tree reconstruction		
Unit - I	**Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; Origin of new genes and proteins; Gene duplication and divergence. Concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.		
Unit - II	**Algorithm in Sequence Alignment:** Why align sequences - similarity v/s homology - heterologs, orthologs, paralogs, xenologs - details of Needleman - Wunsch, Smith-Waterman algorithms with worked out examples - hashing methods with worked out examples – BLAST and FASTA. Basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Representing and scoring a multiple sequences alignment - dynamic programming for multiple sequence alignment pitfalls progressive or hierarchical alignment with worked out examples substitution matrices - evolutionary models - PAM substitution matrices - BLOSUM substitution matrices - gap penalties.		
Unit - III	**Pattern Discovery and Characterization in Protein and DNA Sequences:** Sequence pattern representations – deterministic patterns – regular expressions – probabilistic patterns – sequence logos – general methods of pattern classification – methods for proteins – hidden Markov models and application to analyses of protein sequences – general methods of gene discovery – using HMM, Genemark – artificial neural networks – introduction and their use in gene discovery, GRAIL – Gene discovery using Fourier analysis, GeneScan		
Unit - IV	**Phylogenetic trees:** Phylogenetic representations, Definition and description, various types of trees; Steps in constructing a tree, Consensus (strict, semi-strict, Adams, majority rule, Nelson). Data partitioning and combination. Tree to tree distances, similarity. **Phylogenetic analysis algorithms:** Maximum Parsimony, UPGMA, Transformed Distance, Neighbors-Relation, Neighbor-Joining, jackknife, Probabilistic models and associated algorithms such as Probabilistic models of evolution and maximum likelihood algorithm, Bootstrapping methods. Use of HMM-based Algorithm for MSA (e.g. SAM method).		
Unit-V	**Softwares for phylogenetic analysis:** Survey of software programs available for phylogenetic analysis. Algorithm of CLUSTALW and PHYLIP, MUSCLE, MAFFT and PileUp and their application for sequence analysis (including interpretation of results), concept of dendrogram and its interpretation. Plotting, visualizing & printing phylogenetic trees: TreeView and other tools. Applications of phylogeny analyses, Comparison of Phylogenetic Trees obtained using DNA seq. vs. protein seq. vs. Full genomes.		

Reference and Textbooks:-

Baxevanis, A. D., & Ouellette, B. F. (2004). *Bioinformatics: a practical guide to the analysis of genes and proteins* (Vol. 43). John Wiley & Sons.

Graur, D., & Li, W. H. (2000). Fundamentals of molecular evolution. *Dynamics*, *20*(2), 38.

Michael, M. M. (2001). *Phylogenetic Analysis Of DNA Sequences*.NY: Oxford Press.

Mount, D. W. (2004). *Bioinformatics: sequence and genome analysis. 2nd* (Vol. 692). Cold Spring

Harbor, NY: Cold Spring Harbor Laboratory Press. xii. Page, R. D., & Holmes, E. C. (1998). *Molecular evolution: a phylogenetic approach*. John Wiley & Sons.	
Outcomes	➢ This course covers the basic methods of phylogenetic analysis and their application in fields such as systematics, comparative biology, and molecular evolution. ➢ The course will enable students to use computational approaches for phylogenetic analysis.

Name of the Course Teacher: Dr. M. Karthikeyan

Semester - II			
Course Code: 502202	**Molecualr Modelling and Drug Design**	**Credits: 5**	**Hours: 5**

Objectives	➢ To let students to understand the use of informatics in drug design and development, finding new targets to treat disease; mechanism of drug designing ➢ To understand the concept of molecular modeling, mechanics and interactions
Unit-I	**Unit – I** **Introduction to Molecular Modeling:** Molecular Modeling and Pharmacoinformatics in Drug Design, Phases of Drug Discovery, Target identification and validation, lead identification and optimization , finding of new drug targets
Unit-II	**Unit-II** **Concepts in Molecular Modeling:** Coordinate System; potential energy surfaces; molecular graphics; Quantum mechanics; Molecular Mechanics**:** Features of molecular mechanics, force fields; Bond structure and bending angles – electrostatic, van der Waals and non‐bonded interactions, hydrogen bonding, Inter and intramolecular interactions: Weak interactions in drug molecules; hydrogen bonding in molecular mechanics; Energy concept and its importance in drug action, application of energy minimization.
Unit-III	**Unit-III** **Protein Structure Prediction and Analysis:** Protein Structure prediction methods: Secondary Structure Prediction, Homology modeling, Threading and *abinitio* method, Tools for Structure prediction; Protein structural visualization; Geometry optimization and Loop refinement; Structure validation tools; Ramachandran Plot.
Unit-IV	**Unit-IV** **Structure and Ligand based Drug Design:** Pharmacophore identification and Mapping; methods to identify lead compounds, Molecular Docking, *De‐novo* ligand design, 3D Database Searching in Molecular docking., Virtual Screening, HTVS, , QSAR and Molecular Descriptors and its applications.
Unit-V	**Unit-V** **Receptorology:** Drug‐receptor interactions, receptor theories and drug action; Theories of enzyme inhibition and inactivation; Enzyme activation of drugs and prodrugs. Concept of Drug like molecules; Chemistry of drug‐ metabolism, Pharmacodynamics and pharmacokinetics; Phase‐I and phase‐II transformations; Concept of hard and soft drugs; Chemistry of ADME and toxicity properties of drugs. Lipinski rule, agonist and antagonist.

Reference and textbooks:-

Andrew, R. L. (2001). *Molecular modeling principles and applications*. *Prentice Hall, London*.

Dastmalchi, S., Hamzeh-Mivehroud, M., & Sokouti, B. (2018). *Quantitative structure–activity relationship: a practical approach*. CRC Press.

Hey-Hawkins, E., & Teixidor, C. V. (Eds.). (2018). *Boron-Based Compounds: Potential and Emerging Applications in Medicine*. John Wiley & Sons.

Schlick, T. (2010). *Molecular modeling and simulation: an interdisciplinary guide: an interdisciplinary guide* (Vol. 21). Springer Science & Business Media.

Sehgal, S. A., Mirza, A. H., Tahir, R. A., & Mir, A. (2018). *Quick Guideline for Computational Drug Design*. Bentham Science Publishers.

Outcomes	➢ The students would know the steps for designing new drugs, target identification and validation ➢ They would be able to understand the theory of inhibition and inactivation of enzymes, drug deactivation and susceptibility

Name of the Course Teacher: Dr. Sanjeev Kumar Singh

Semester-I			
Course code: 502503	**Computational Biology**	**Credit:5**	**Hrs: 5**
Objectives	➢ To provide students with the basic knowledge of biosimilar, computational biology and their advances of synthetic biology. ➢ To facilitate the students to attain skills in basic computational biology, sequence matching and its various biomedical applications.		
Unit-1	**Biosimilars:** Introduction to biosimilars, Definition, Examples of Biosimilars-Genetically engineered products of biosimilars, Molecular Complexity of biosimilars. Critical manufacturing parameters of biosimilars and Challenges-Modifications linked to the process, conversion and formulation. Concept of expression cassette and vector, Host cell and expression system. Non Clinical and Clinical Aspects of Biosimilars-Preclinical approach and Clinical approach.		
Unit-2	**Introduction to Computational Biology:** Nature and scope of Computational Biology, Alignment definition, Pairwise sequence alignment, biological interpretation of the alignment problem, scoring alignment, Global alignment, local alignment, overlap alignment, banded alignment, normalized local alignment, maximizing Vs minimizing score, similarity and distance measures, PAM matrices, BLOSUM matrices, comparison between PAM and BLOSUM matrices, Application of substitution matrices.		
Unit-3	**Pairwise sequence matching analysis:** Sequence matching method- Dot plot visualization method, Dynamic programming method, Word method, Bayesian method, progressive method, Markov chain model, Hidden Markov Models and Kernal methods.		
Unit-4	**Computational Sequences and Maps:** General ideas of sequence alignment, multiple sequence alignment, Restriction map-Graph, Interval graphs and Measuring fragment sizes. Multiple maps-double design problems, reflection, overlap equivalence, overlap size equivalence, restriction map and border block graph, Cassettle transformation of restriction map.		
Unit-5	**Advances of Computational Biology:Synthetic biology**- Ethical issues of Synthetic Biology, Computational Synthetic biology, Codon optimization, AND gate and OR gate in biology, Operons, Switches and clocks, Re-pressilator. **Computational QuantumMechanics**- One electron atoms, Polyelectron atoms and molecules, Molecular orbitals, Hartree-Fock Equations, Molecular Properties using ab initio methods, Semi-empirical methods, Huckel Theory.		

Reference and Text Books:

Aluru, S. (2005). *Handbook of computational molecular biology*. Chapman and Hall/CRC.

Gutka, H. J., Yang, H., & Kakar, S. (Eds.). (2018). *Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development* (Vol. 34). Springer.

Haubold, B., & Wiehe, T. (2006). *Introduction to computational biology: an evolutionary approach*. Springer Science & Business Media.

Najarian, K., Najarian, S., Gharibzadeh, S., & Eichelberger, C. N. (2009). *Systems biology and bioinformatics: a computational approach*. CRC Press.

Prugnaud, J. L., & Trouvin, J. H. (Eds.). (2012). *Biosimilars: A New Generation of Biologics*. Springer Science &Business Media.

Ramachandran, K. I., Deepa, G., & Namboori, K. (2008). *Computational chemistry and molecular modeling: principles and applications*. Springer Science & Business Media.

Voigt, C. (Ed.). (2011). *Synthetic biology, part b: computer aided design and DNA assembly*. Academic Press.

Voigt, C., & Voigt, C. A. (Eds.). (2011). *Synthetic Biology, Part A: Methods for Part/Device Characterization and Chassis Engineering*. Academic Press.

Waterman, M. S. (2018). *Introduction to computational biology: maps, sequences and genomes*. Chapman and Hall/CRC.	
Outcomes:	➢ The students will obtain basic knowledge about the biosimilar, sequence matching analysis and dynamic programming methods. ➢ The students will gain current research problems using computational approaches.

Name of the Course Teacher: Dr. P. Boomi &

Dr. V.K Langeswaran

SEMESTER-II			
Course Code: 502204	**Programming in Scripting Languages (PYTHON, PERL & R)**	**Credits:5**	**Hours:5**

Objectives	➢ To introduce students to pros and cons of scripting vs. compiled programming languages. ➢ identify appropriate statistical methods for the data or problems and conduct their own analysis using the R environment
Unit-I	**PERL:** Scalar data, Numbers, Strings, Variables, Operators, Hierarchy of operators, Variable interpolation, **Basic I/O, Lists and Arrays:** Literal Representation, Variables, Array Operators and Functions, Scalar and List Context, **Control Structures:** Statement Blocks, The If control structure, While control structure, Hashes, Hash Functions, Use of Hashes, Pointers, Database Connections and Database Operations.
Unit-II	**Introduction to Python:** Python interpreter and interactive mode, values and data types, variables, expressions, statements, tuple assignment, precedence of operators, comments, modules and functions, function definition and use, flow of execution, parameters and arguments, **Control Flow, Functions: Conditionals:** Boolean values and operators, if, if-else, if-elif-else, Iteration: state, while, for, break, continue, pass, **Fruitful Functions:** return values, parameters, local and global scope, function composition, recursion, **Strings:** string slices, immutability, string functions and methods, string module, Lists as arrays.
Unit-III	**Functions (Subroutines)in Python**: Function Definition, Calling a Function, Passing Parameters, Local Variables, Returning Values, Special Variables and its Types, File handle Special Variables, Local and Global Special Variables, **Regular Expressions:** Concepts About Regular Expressions, Simple Uses of Regular Expressions, Patterns Matching, Match Operator, Simple Matching, Literal Matching, The Split and Join Functions, Substituting, Splitting, Quantifiers, Metacharacters, Assertions, Character Classes, Alternatives, Transliteration. **Assignments**: Simple Uses of Regular Expressions, Patterns Matching, , Alternatives, Transliteration
Unit-IV	**Python-Lists, Tuples, and Dictionaries: Lists:** operations, slices, methods, loop, mutability, aliasing, cloning, parameters, **Tuples:** assignment, tuple as return value, **Dictionaries:** operations and methods, advanced list processing, list comprehension, **Illustrative programs:** selection sort, insertion sort, mergesort. **Files, Modules, and Packages: Files and exception:** text files, reading and writing files, format operator, command line arguments, errors and exceptions, handling exceptions, modules, packages. **Assignments:** selection sort, insertion sort, merge sort, command line arguments, errors and exceptions, handling exceptions
Unit-V	**Introduction to R-Programming:** Introduction R Nults and Bolts (I), R Nults and Bolts (II), Getting Data In and Out of R, Control Structures and Functions, Loop Functions, Data Manipulation, String Operations, Packaging, Debugging and Object Oriented Programming, Data Visualization, Clustering, Regression and Classification, Data Analytics.

Reference and Text Books:-

Chang, J., Chapman, B., Friedberg, I., Hamelryck, T., De Hoon, M., Cock, P., & Talevich, E. (2017). Biopython Tutorial and Cookbook. *Update*, 15-19.

Christiansen, T., & Torkington, N. (2003). *Perl Cookbook: Solutions & Examples for Perl Programmers*. "O'Reilly Media, Inc.".

<table>
<tr><td colspan="2">DSVGK, K. (2014). Basics in PERL and BioPERL: A programming guide. GRIN Verlag.
Lander, J. P. (2018). R for everyone: advanced analytics and graphics. Pearson Education.
Rossum, G. (2011). The Python language reference manual: revised and updated for Python 3.2. Eastbourne, United Kingdom: Network Theory.
Sandip, R., (2017). R Programming for Beginners. McGraw Hill Education..
Sedgewick, R., Wayne, K., & Dondero, R. (2015). Introduction to programming in Python: An interdisciplinary approach. Addison-Wesley Professional.
Till, D., & Till, D. (1996). Teach yourself Perl 5 in 21 days. Sams Pub..
Timothy, A. B. (2015). Exploring Python. Mc-Graw Hill Education (India) Private Ltd.</td></tr>
<tr><td>Outcomes</td><td>➢ Understand the concepts of object-oriented programming as used in Python: classes, subclasses, inheritance, and overriding. Understand the basics of OO design. Design and revision of Perl scripts.
➢ Perform appropriate statistical tests using R. Create and edit visualizations with R.</td></tr>
</table>

Name of the Course Teacher: Dr. RM. Vidhyavathi

Semester - II			
Course Code: 502205	**Molecular Biology and Biochemical Techniques**	**Credits: 5**	**Hours :5**

Objectives	➢ Experimental design and hypothesis testing. ➢ Data interpretation, including standard curve interpolation (graphing) and determining molecular weight of an unknown protein or genotype.
Unit - I	**Approaches to Biochemical Techniques:** Bio□safety rules and regulations and Good Laboratory Practice (GLP), Material safety Data sheets (MSDS). Preparation of Reagents, buffers, pH Analysis, Various Centrifugation methods, Quality and Quantity analysis of nucleic acids by Spectrophotometer, Bio Photometer, nanodrop. Quantification of Proteins by Lowry's and Bradford's methods.
Unit - II	**Isolation and Separation Techniques:** Cell culture, Isolation and Separation of Genomic DNA from plants/human/microorganisms; Plasmids isolation from microorganisms; RNA from cells; Agarose Gel Electrophoresis; Isolation, separation and analysis of Proteins by Native□PAGE and SDS□PAGE.
Unit - III	**Amplification of Genes and Molecular Markers:** Gene amplification and Screening techniques: Primer Design, PCR; Realtime PCR (RTqPCR)/analysis, Blotting techniques: Southern, Northern and Western Blots; Bio Probe (Demonstration) and Radioactive probe (Theory). Molecular Markers by RFLP, AFLP, RAPD methods (Demo).
Unit - IV	**Chromatography Techniques:** Chromatography: Partition Chromatography, Ion Exchange Chromatography, Gel filtration Chromatography, Affinity Chromatography, HPLC and FPLC (Demonstration). Separation of amino acids/compounds by Paper Chromatography, Thin Layer Chromatography.
Unit-V	**Microscopes and immune techniques:** Microscopes and immune techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes. Antigen and Antibody preparation, immunoprecipitation, Immunohistochemistry, ELISA & its applications, Flowcytometry and immunofluorescence microscopy, Confocal microscopy and FISH (Theory).

Reference and Textbooks:-

Bansal, M. P. (2013). *Molecular Biology and Biotechnology.* Basic Experimental Protocols, New Delhi: TERI**.**

David L. Nelson., & Michael. (2017). *Lehninger Principles of Biochemistry (7th ed.).* International Edition, WH Freeman.

Heldt, H. W. (2004). *Plant Biochemistry (*3rd ed.) Academic Press.

John, M. W & Ralph, R. (2002). *Molecular Biology and Biotechnology (*4th ed.*).* UK; University of Hertfordshire, Hatfield.

Michael M. Cox., Michael O'Donnell., &Jennifer, D. (2015). *Molecular Biology: Principles and Practice Hardcover (*1st ed.). WH Freeman.

Miller, J. M. (2005). *Chromatography: Concepts and Contrasts (*2nd ed.). Wiley-Interscience.

Rodney &Royer, (2004). *Modern Experimental Biochemistry,* India: Pearson education,.

Outcomes	➢ Students will analyze structure-function relationships of genes and proteins from bacteria to eukaryotes using genomic methods based on evolutionary relationships. ➢ Students will use current biochemical and molecular techniques to plan and carry out experiments.

Name of the Course Teacher: Dr. M. Karthikeyan, Dr. J. Joseph Sahayarayan & Dr. V.K Langeswaran

Semester - III			
Course Code: 502301	**Genetics and Genetic Engineering**	**Credits: 4**	**Hours :4**

Objectives	➢ Understand the concepts, introduction of genetics and genetic engineering, introduction about restriction enzymes, ligases, polymerases, vectors, their types, sources and their roles in genetic engineering. ➢ Knowledgeable in basic techniques of molecular biology and their applications in various aspects.
Unit - I	**Basics of Genetics**: Definition and scope of Genetics, Mendelian genetics: Mendel's experiments, Law of segregation, monohybrid crosses, Law of independent assortment and exceptions, introduction to linkage and recombination, Inheritance in families, pedigree symbols, autosomal dominant, autosomal recessive X-linked inheritances. Multi-factorial, Mitochondrial and complex inheritance
Unit - II	**Gene Interactions and Mutations**: Definition and types of mutation, Eye color in Drosophila, Blood groups and Rh factor in Human. Genetic problems related. Gene interactions: Deviations from Mendelism: Inter allelic-Complementry gene interaction Ex. *Lathyrus odoratus.* Supplementry gene interaction Ex. Grain color in Maize. Epistasis: - Dominant –Ex. Fruit color in *Cucurbita pepo*. Epistasis: - Recessive –Ex. Coat color in Mice. Inter allelic Non Epistatic: Ex. Comb pattern in Fowl.
Unit - III	**Gene Expression Studies:** Prokaryotic and Eukaryotic Systems, Prokaryotic and Eukaryotic genome organization, structure and mechanisms of gene expression, factors involved in gene regulation, Basic concepts of replication, Regulation of translation, Post transcriptional modifications, processing of DNA, RNA and proteins methods for studying gene expression and regulatory sequences, large-scale expression analysis, Recombinant DNA technology, overexpression- Isolation and purification of proteins-various techniques, Mechanisms of genome alterations.
Unit - IV	**Oncogenetics**: Properties of malignant cells, Types of genes - Proto oncogenes, Oncogenes, Cellular oncogenes, Tumor Suppressor genes, Chromosomal abnormalities associated with the specific malignancies- APL, CML & Retinoblastoma.
Unit-V	**Genetic Engineering Strategies**: Genetic transformation by using *Agrobacterium tumefaciens,* virulence, Ti and Ri plasmids, binary vectors and their utility, T DNA transfer, *Agrobacterium* mediated gene delivery, selectable markers, Monocot and dicot transformation, Management of transgenic plants, Applications of plant genetic engineering, Abiotic and biotic stress resistance, Pest Resistance, Herbicide Resistance, Mechanism of gene action, fruit ripening process, Improvement of the nutritional quality of seeds, Edible vaccines, Issues in Genetic Engineering, Bio and Environmental safety of transgenic products.

Reference and Textbooks:-

Bruce. R. & Korf. (2013) *Human Genetics and genome (4th ed.).* Kindle edition.

Gunder, L., & Martin, S. (2010). *Essentials of medical genetics for health professionals*. Jones & Bartlett Learning.

Jin Kim. (2017) *Cancer Genetics and Genomics for Personalized Medicine (2nd ed.).*

Strachan, T., & Read, A. P. (2012). *Human molecular genetics.* Garland science. *Edition.*

Watson, J. D., Caudy, A. A., Myers, R. M., & Witkowski, J. A. (2007). *Recombinant DNA: genes and genomes: a short course*. Macmillan.

Outcomes	➢ Understand and think about the basics of Genetic and Genetic Engineering. ➢ To understand the role, use and types of different DNA modifying enzymes viz. Polymerases, Nucleases, restriction endonuclease, ligases etc.

	➢ Acquire basic knowledge of DNA sequencing methods from conventional (Sanger sequencing) to High throughput Next generation sequencing technology, their principle, chemistry, theory and types

Name of the Course Teacher: Dr. J. Joseph Sahayarayan

Semester - III			
Course Code: 502302	**Structural Biology**	**Credits: 5**	**Hours :5**
Objectives	i. To demonstrate and comprehend basic knowledge underlying the central concepts (elucidation of protein – structure function) in the structural biology through theoretical and practical methodologies. ii. Proteomics based research such as crystal and solution structure determination of biomolecules.		
Unit - I	**Introduction to Crystallography**: General concepts, overview of Crystals and their properties. Single crystal, powder crystal and Amorphous solid. Unit cell, Lattices, Planes and Indices, stereographic projection of point groups and space groups. Crystal systems and Symmetry. X-ray generator, diffraction and its applications; Laue equations, Braggs' Law and its applications in X-ray diffraction, Atomic scattering factor, Structure factor and Electron density calculations, phase problem		
Unit - II	**Structure Determination Techniques**: Synchrotron radiation and its implications in structure determination. Introduction to X-ray Free Electron Laser technology (XFEL), importance and applications. Cryo-electron microscopy, Fiber, Powder and Neutron diffraction. NMR- Introduction and general aspects of structure determination. NMR Sample preparation. Importance of NMR in Structural Biology, Cryo-EM.		
Unit - III	**Small Molecule X-ray Crystallography**: Crystal growth - various techniques, Crystallization of small molecules from synthetic compounds, Single crystal X-ray data collection, data reduction. Structure solution–Application of direct methods of solving a small molecule, Patterson method. Refinement of crystal structure – Fourier refinement, Fourier synthesis and least squares techniques. Structure validation and analysis.		
Unit - IV	**Protein X-ray Crystallography**: Crystallization methods (sitting, hanging drop, microbatch methods etc.,), Soaking and Co-Crystallization methods, Heavy atoms screening, X-ray data collection, data reduction and Integration, various Protein structure determination methods, interpretation of electron density maps, structure solution, structure refinement, Structure Validation and Analysis. Structural Classification, Folds and Motifs, Deposition of structure in Protein Data Bank (PDB).		
Unit-V	**Molecular Geometries and Interaction**: R-factors, B-factors, Density fit, Unit map, Bulk-solvent corrections. Internal geometry of molecule (Bond lengths, Bond angles and Torsion angles), Conformation of small and macromolecule structures, Ramachandran Plot, thermal motion analysis. Planarity, Chirality, covalent and non-covalent interactions-hydrogen bonds, hydrophobic, van der Waals forces, disulphide bonds etc. Application of X-ray crystallography in drug design.		

Reference and Textbooks:-

Altman, R. B., Flockhart, D., & Goldstein, D. B. (Eds.). (2012). *Principles of pharmacogenetics and pharmacogenomics*. Cambridge University Press.

Falconer, D. S., & Mackay, T. F. C. (1996). *Introduction to genetics*. *Essex, England*: Pearson Education Ltd. .

Lam, Y. W. F., & Scott, S. R. (Eds.). (2013). *Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation*. Academic Press.

Mount, D. W. (2004). *Bioinformatics: sequence and genome analysis. 2nd* (Vol. 692). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. xii.

Rapley, R., & Harbron, S. (Eds.). (2004). *Molecular analysis and genome discovery*. J. Wiley.

Richard, J.R. (2003) *Analysis of Genes and Genomes:* Wiley Publications.

Sankoff, D., & Nadeau, J. H. (2000). *Comparative genomics: gene order dynamics, map alignment and the evolution of gene families*. In *Series in Computational Biology* (Vol. 1). Kluwer Academic

Press Dordrecht NL. Yan & Qing (2014). *Pharmacogenomics in Drug Discovery and Development* (*2nd ed.)*.New York: Springer.	
Outcomes	i. To offer new insights on the improved methods available for isolation, purification, and stabilization of native and modified proteins. ii. Basic research on crystallization and the development of new methods for crystal manipulation that could lead to novel structure determination that would have immediate contribution to the established structural research communities.

Name of the Course Teacher: Dr. J. Jeyakanthan

Semester - III			
Course Code: 502303	**Pharmacogenomics**	**Credits: 5**	**Hours :4**
Objectives	➢ To understand how the individualization of drug therapy based on a person's genetic makeup can optimize the effectiveness of that therapy while reducing unwanted drug effects. ➢ To help students to gain knowledge about the NGS technologies useful in Personalized drug designing.		
Unit - I	**Introduction and Concepts in Genomics**: 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, gene expression profiling; identification of SNPs, SNP database (DbSNP).		
Unit - II	**Comparative genomics**: Basic concepts and applications, BLAST2, MegaBlast algorithms, PipMaker, AVID, Vista, MUMmer, applications of suffix tree in comparative genomics, synteny and gene order comparisons, Comparative genomics databases: Clusters of Orthologous Groups (COGs) 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, Polymorphisms-Introduction, types and importance in Drug targets. Prediction of structural changes among sequences by the influence of polymorphisms.		
Unit - III	**Pharmacogenomics Overview, Concepts and Applications**: Introduction, basic concepts about genetics diseases. Personalized medicine- introduction and importance. The genetics of therapeutic targets and gene-based targets. Pharmacogenomics necessity in drug designing. Drug response to patients, Structural influence in the Drug response. Efficacy and metabolism of drugs. Pharmacogenomics vs. Structural Pharmacogenomics. Drug metabolism pathways and adverse drug reactions. Tools for pharmacogenomic analysis. Pharmacokinetics (PK), Pharmacodynamics (PD). Process in Structural Pharmacogenomics - Target Structure optimization, Validation, lead identification, ADME prediction, synthesis, assays and Clinical trials.		
Unit - IV	**Pharmacogenomics analysis, Techniques and Case study:** Role of SNP in Pharmacogenomics, SNP arrays DNA microarray: database and basic tools, Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases. DNA microarray: understanding of microarray data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools (especially clustering approaches). Application of NGS in Pharmacogenomics: Emergence of Next generation sequencing, Illumina Genome Analyzer, Nanopore Sequencing, Single Molecule Real Time DNA sequencing, Comparison of Next generation sequencing techniques, Drawbacks of NGS, NGS File formats, & applications. Ethical issues for Pharmacogenomics; Future of Pharmaceuticals.		
Unit-V	**Case Study Examples - Cancer Pharmacogenomics:** Concepts of cancer genomics, potential of Bioinformatics in cancer diagnosis, prognosis and treatment, cancer specific databases: TCGA, ICGC,COSMIC, importance of copy number alterations in Cancer, Bioinformatics methods for detecting copy number alterations, correlating clinical outcomes with genomic data, Survival analysis and use of bioinformatics for personal medicine.		

Reference and Textbooks:-

Altman, R. B., Flockhart, D., & Goldstein, D. B. (Eds.). (2012). *Principles of pharmacogenetics and pharmacogenomics*. Cambridge University Press.

Falconer, D. S., & Mackay, T. F. C. (1996). *Introduction to quantitative genetics*. London. *UK: Prentice Hall*, 56-70.

Lam, Y. W. F., & Scott, S. R. (Eds.). (2013). *Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation*. Academic Press.

Mount, D. W. (2004). *Bioinformatics: sequence and genome analysis. 2nd* (Vol. 692). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. xii

Richard, J.R. (2003). *Analysis of Genes and Genomes.* Wiley Publications.

Yan& Qing (2014). *Pharmacogenomics in Drug Discovery and Development (*2nd ed). NY: Springer.

Outcomes	➢ The goal of the course is to give students an understanding of the principles of human genetics and genomics as they apply to improving the problems in drug therapy optimization and patient care. ➢ Students completing this course will gain an understanding of how genetic differences between individuals can impact the outcome of drug therapy in a positive and negative way.

Name of the Course Teacher: Dr. M. Karthikeyan

Semester III			
Course Code: 502304	Lab - III Computer Aided Drug Design (CADD)	**Credits: 4**	**Hours: 8**
Objectives	• To provide hands on experience on various computational tools used in drug designing • To let them understand the advantages and limitations of available molecular modeling software		
Unit - I	Molecular modeling and Virtual Screening: Energy minimization and optimization, conformational analysis, global and local minima; Bioactive vs. global minimum conformations; Automated methods of conformational search; Molecular graphics; Computer methodologies behind molecular modeling, High throughput virtual Screening; Shape based virtual screening; Structure similarity searching; ADME/T Property prediction; Structural Fingerprint search.		
Unit - II	Pharmacophore: Concept of Pharmacophore generation and analysis, pharmacophore mapping, methods of conformational search used in pharmacophore mapping; Comparison between the popular pharmacophore methods like catalyst, HipHop, DiscoTech, GASP, etc. with practical examples. Structure based and Energy based pharmacophore models.		
Unit - III	Quantitative Structure Activity relationship (QSAR): QSAR Methodology, QSPR, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Experimental and theoretical approaches for the determination of physico□chemical property; parameter inter□dependence; linearity versus non-linearity; importance of biological activity; Regression analysis, 2D-QSAR, 3D□QSAR with case studies. CoMFA and CoMSIA; Tools for QSAR studies.		
Unit - IV	Molecular Docking and Molecular Dynamics Simulations: Different types of molecular docking; Rigid docking; flexible docking; Protein□ Protein docking. Induced fit docking with case studies. QM/MM docking; Constraints and restraints in Molecular Docking. Significance of partial charges in molecular docking. Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Solvent effects in Molecular Dynamics; Conformational changes in Molecular Dynamics. Biomolecular Simulations; Free energy Calculations; Restraint Potentials, Importance of Force Field in Dynamics, Conformational Sampling: Energy Minimization, Monte Carlo Simulations, Membrane Simulation, Metadynamics		
Unit-V	Hands on training: Energy Minimization and Optimization techniques, In silico Virtual screening techniques: Structure based, Shape based, Pharmacophore based, etc, Structural similarity and Finger print search, ADME/T Property prediction, Molecular Docking: Rigid, Flexible and QM/MM 2D and 3D QSAR along with CoMFA and CoMSIA, Pharmacophore Derivation and Pharmacophore Mapping, Molecular Electrostatic Potential (MESP) analysis, Protein-Protein Interaction and Protein-peptide Interaction, Molecular Dynamics Simulation using Protein, Protein-ligand and Protein-DNA complexes		

Reference and Textbooks:-

Cavasotto, C. N. (Ed.). (2015). *In silico drug discovery and design: theory, methods, challenges, and applications*. CRC Press.

Gore, M., & Jagtap, U. B. (Eds.). (2018). *Computational drug discovery and design*. Humana Press.

Grover, A. (2017). *Drug Design: Principles and Applications*. Singapore: Springer Nature Singapore Pte Ltd.

Marx, D., & Hutter, J. (2012). *Ab initio molecular dynamics: basic theory and advanced methods*.

Cambridge University Press. Young, D. C. (2009). *Computational drug design: a guide for computational and medicinal chemists*. John Wiley & Sons.	
Outcomes	➢ They would be able to explain the concepts of molecular modeling, pharmacophore, virtual screening, molecular docking, 3D QSAR etc., ➢ They would be able to analyze the problem which could arise in drug designing methods

Name of the Course Teacher: Dr. Sanjeev Kumar Singh

SEMESTER-IV			
Course Code: 502401	**Machine Learning and Artificial Intelligence**	**Credits:3**	**Hours:3**

Objectives	➢ To create appreciation and understanding of both the achievements of AI and it creates an understanding of the basic issues of knowledge representation and Logic and blind and heuristic search, as well as an understanding of other topics such as minimal, resolution, etc. that play an important role in AIprograms. ➢ Machine Learning, in particular focusing on the core concepts of supervised and unsupervised learning. Students will learn the algorithms which underpin many popular Machine Learning techniques, as well as developing an understanding of the theoretical relationships between these algorithms.
Unit-I	**Introduction To Al And Production Systems:** Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics, Specialized production system, Problem solving methods, Problem graphs, Matching, Indexing and Heuristic functions, Hill Climbing, Depth first and Breath first, Constraints satisfaction, Related algorithms, Measure of performance and analysis of search algorithms.
Unit-II	**Representation of Knowledge:** Game playing, Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic, Structured representation of knowledge.
Unit-III	**Introduction to Machine Learning:** Learning Problems, Perspectives and Issues, Concept Learning, Version Spaces and Candidate Eliminations, Inductive bias, Decision Tree learning, Representation, Algorithm, Heuristic Space Search.
Unit-IV	**Classification in Machine Learning:** Naïve Bayes Classifier, Probability estimation, Required data processing, Feature selection: Mutual information, Classifier, K-Nearest Neighbors, K-Nearest Neighbor algorithm, Support Vector Machines, Linear learning machines and Kernel space, SVM for classification and regression problems. **Clustering:** Distance measures, Different clustering methods (Distance, Density, Hierarchical), Iterative distance-based clustering, K-Medoids, k-Mode and density-based clustering
Unit-V	**Advanced Learning** : Learning Sets of Rules – Sequential Covering Algorithm – Learning Rule Set – First Order Rules – Sets of First Order Rules – Induction on Inverted Deduction – Inverting Resolution – Analytical Learning – Perfect Domain Theories – Explanation Base Learning – FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning.

Reference and Text Books:-

Alpaydin, E. (2014). *Introduction to machine learning*. MIT press.

Khan, S. (2008). Ethem Alpaydin. Introduction to Machine Learning (Adaptive Computation and Machine Learning Series). The MIT Press, 2004. ISBN: 0 262 01211 1 Price£ 32.95/$50.00 (hardcover). xxx+ 415 pages. *Natural Language Engineering*, *14*(1), 133-137.

Marsland, S. (2014). *Machine learning: an algorithmic perspective*. Chapman and Hall/CRC.

Mitchell, T. M. (1997). Machine learning. 1997. *Burr Ridge, IL: McGraw Hill*, *45*(37), 870-877.

Rich, E. Kevin Knight. Shivashankar B Nair, 2009. *Artificial Intelligence Third Edition, McGraw-Hill Publishing Company Limited, New Delhi.*

Russell, S. J., & Norvig, P. (2016). *Artificial intelligence: a modern approach*. Malaysia; Pearson Education Limited.

Saikat, D., Chandramouli, S., & Das, A. K. (2018). *Machine Learning*. Pearson Education.	
Outcomes	➢ Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them. ➢ Formulate and solve problems with uncertain information using Bayesian approaches.Develop an appreciation for what is involved in learning from data.

Name of the Course Teacher: Dr. RM. Vidhyavathi

Semester - IV			
Course Code: 502402	**Systems Biology**	**Credits: 3**	**Hours : 4**

Objectives	➢ To understand how genomics applications are used to unravel the biology of life and the basic principles of systems biology. ➢ To provide the basis for gaining insight in bioinformatics and computational genomics.
Unit - I	**Introduction and scope of proteomics:** Components of a complex mixture and Protein sequencing; MALDI TOF MS, QTrap MS/MS, 2D Gel electrophoresis and Protein microarrays. qRT PCR and Proteomics. Proteomic approach for Clinical studies: Protein Biomarker Discovery and Validation - Body fluid profiles, blood disease profiles, diabetes profiles, infectious diseases.
Unit - II	**Protein arrays**: basic principles, Computational methods for identification of polypeptides, Bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as Inter Pro), Protein-protein interactions: databases such as STRINGS and DIP; PPI Modeling in biological systems.
Unit - III	**Protein complexes and Networks**: Protein binding site analysis, Protein interaction networks, Regulatory networks, Structures of regulatory networks, Neural Network models.
Unit - IV	**Glycomics**: The Challenge and Promise of Glycomics, Identification of carbohydrates, Glycolipids, Glycoproteins, Glycan Microarrays and Glycan Determinants, Metaglycomes, Glycan Recognition Molecules, Lipidomics, Fluxomics, Biomics: systems analysis of the biome. Transcriptomics &Metabolomics and its applications.
Unit-V	**Systems Biology**: Introduction, Integrating Networks. Computer Simulation of the whole Cell. Human Erythrocyte Model and its applications. Software for Modeling, E□CELL, V□CELL and GROMOS. Simulation of cellular subsystems, network of metabolites and enzymes, Signal transduction networks, Gene 5 regulatory networks, metabolic pathways: databases such as KEGG, EMP, MetaCyc, AraCyc.

Reference and Textbooks:-

Giacovazzo, C. (2013). Phasing in crystallography: a modern perspective. *Rendiconti Lincei*, *24*(1), 71-76.

Hargittai, I. (2009). Christopher Hammond: The basics of crystallography and diffraction.

Ladd, M. F. C., Palmer, R. A., & Palmer, R. A. (2003). *Structure determination by X-ray crystallography* (p. 71). New York: Plenum Press.

Monaco, H. L., Artioli, G., Viterbo, D., Ferraris, G., & Giacovazzo, C. (2011). *Fundamentals of crystallography* (Vol. 7). C. Giacovazzo (3rd ed.). Oxford: Oxford University Press.

Paufler, P., Stout, G. H., & Jensen, L. H. (1991). X□ray structure determination. John Wiley & Sons, New Yark□Chichester□Brisbane□Toronto□Singapore 1989. 453 Seiten. 35.50£. ISBN 0–471–60711–8. *Crystal Research and Technology*, *26*(8), 1070-1070.

Rhodes, G. (2010). *Crystallography made crystal clear: a guide for users of macromolecular models*. Elsevier.

Outcomes	➢ Describe the development of Omics technologies, with emphasis on genomics and proteomics. ➢ To use bioinformatics techniques to query examples of genomic and proteomic databases to analyze cell biology. ➢ Understand the principles of integrative analysis methods for biological system analysis and interactions.

Name of the Course Teacher: Dr. J. Joseph Sahayarayan & Dr. P. Boomi

Semester - IV			
Course Code: 502403	**Small and Macromolecular Crystallography**	**Credits: 4**	**Hours :8**

Objectives	To make the students: i. Provide knowledge and Familiarization with methods and techniques in Macromolecular Crystallization, Nucleic acids and Small Biologically Active Compounds. ii. To understand different crystal systems and symmetry that follows along with space groups to classify the crystals accordingly depending on their arrangement. iii. To address about diffraction experiments, data processing (using various software(s)) and data validation that constitute the Protein Crystallization process. iv. To comprehend with precision of various phase solving methods such as direct methods, molecular replacement and with the use of heavy atom derivatives that surfaces usually in small/macromolecular crystallization. . v. To provide knowledge about model building methods and structure refinement using various crystallographic software(s) and also to be aware in analyzing the protein structures deposited in databases such as CCDC and PDB.
Unit - I	**Small Molecule structure Determination**: Small molecule crystallization methods, X-ray diffraction data collection, structure determination methods, structure refinement and Validation method, structural analysis, conformations and Interaction analysis.
Unit - II	**Macromolecule structure Determination**: Cloning, Expression, Purification of Protein and Nucleic acid. Crystallization methods (Hanging drops, Sitting drops and Microbatch methods etc.,) X-ray diffraction data collection, structure determination methods (MR/ SIR/ MIR/ SAD/ MAD), structure refinement, electron density map calculation, model building and Validation, Structural and Interaction analysis.
Unit - III	**Hands on Training:** Synthetic Compounds**-** Crystallization using different methods (slow evaporation etc.) in different solvents such as methanol, ethanol etc., Structure determination using SHELXS program, Structure refinement using SHELXL, validation and analysis.
Unit - IV	**Hands on Training**: Lysozyme protein - Crystallization, Data Collection, Demo of CCP4/CNS programs, Three-Dimensional Structure determination, Structure refinement, electron density map calculation, model building, validation (Ramachandran Plot) and analysis.

Reference and Textbooks:-

Banaszak, L. J. (2000). *Foundations of structural biology*. Elsevier.

Bourne, P.E. & Helge Weissig, H. (2003) "Structural bioinformatics"; Wiley-Liss

Giacovazzo, C. (2013). Phasing in crystallography: a modern perspective. *Rendiconti Lincei*, *24*(1), 71-76.

Hargittai, I. (2009). Christopher Hammond: The basics of crystallography and diffraction.

Ladd, M. F. C., Palmer, R. A., & Palmer, R. A. (2003). *Structure determination by X-ray crystallography* (p. 71). New York: Plenum Press.

Liljas, A., Liljas, L., Piskur, J., Nissen, P., & Kjeldgaard, M. (2009). *Textbook of structural biology*. World Scientific Publishing Company.

Monaco, H. L., Artioli, G., Viterbo, D., Ferraris, G., & Giacovazzo, C. (2011). *Fundamentals of crystallography* (Vol. 7). C. Giacovazzo (3rd ed.). Oxford: Oxford University Press.

Paufler, P., Stout, G. H., & Jensen, L. H. (1991). X□ray structure determination. John Wiley & Sons, New Yark□Chichester□Brisbane□Toronto□Singapore 1989. 453 Seiten. 35.50£. ISBN 0–471–60711–8. *Crystal Research and Technology*, *26*(8), 1070-1070. Rhodes, G. (2010). *Crystallography made crystal clear: a guide for users of macromolecular models*. Elsevier.	
Outcomes	i. Design the process steps leading to determination of crystal structures of small and macro molecules. ii. Define what a crystal is and describe the differences in properties of molecular and macro molecular crystals. iii. Explain the differences between crystallization of small molecules and macromolecules; choose proper methods for protein crystallization. Analyze crystallization experiments under a polarization microscope. iv. Characterize X-ray sources and types of detectors, explain a diffraction experiment based on the Evald construction, process diffraction images, and validate data. v. Characterize methods of phase problem solving and choose proper methods for molecular and macromolecular structures. vi. Build protein models based on experimental electron density maps and know procedures of map improvement. Explain algorithms for automatic model building. vii. Define electron density maps and choose the proper algorithms for structure refinement. Use specific crystallographic software for structure visualization and refinement. Validate the final structures.

Name of the Course Teacher: Dr. J. Jeyakanthan

Code: 502999 Project work

Program: **M.Sc.,**	Semester: **IV (2019-20)**
Course Title and Code: **Project work (502999) 8 Credits**	Class Time: **10 - 5 From December to April**
Name of the Course Teacher	**Prof. J. Jeyakanthan**
Mobile: **+91 - 97898 09245**	Email: **jjkanthan@gmail.com**
Name of the Course Teacher	**Prof. Sanjeev Kumar Singh**
Mobile: **+91 - 98944 29800**	Email: **skysanjeev@gmail.com**
Name of the Course Teacher	**Dr. M. Karthikeyan**
Mobile: **+91 - 94869 81874**	Email: **mkbioinformatics@gmail.com**
Name of the Course Teacher	**Dr. RM. Vidhyavathi**
Mobile: **+91 - 94448 35869**	Email: **vidhyamiss@gmail.com**
Name of the Course Teacher	**Dr. J. Joseph Sahayarayan**
Mobile: **+91 - 90475 64087**	Email: **bioinformaticsjoseph2015@gmail.com**
Name of the Course Teacher	**Dr. P. Boomi**
Mobile: **+91 -9486031423**	Email: **pboomi1983@gmail.com**
Name of the Course Teacher	**Dr. V.K. Langeswaran**
Mobile: **+91 - 98844 95511**	Email: **dr.langeswaran@gmail.com**

Major Research Areas

- Small and Macro molecule X-ray Crystallography.
- 3D Quantitative Structure - Activity Relationship (3D-QSAR).
- Human Molecular Genetics.
- Pharmacogenomics.
- Cheminformatics.
- Quantum Pharmacology.
- Computer Aided Drug Designing (CADD).
- Data mining, Data warehousing and Networking.
- Plant tissue Culture, Genetic Transformation, Plant Molecular Biology, Virology and Plant Pathology.
- Molecular Oncology, Pharmacology and Environmental Toxicology.

Course Brief:

The study of PG course in bioinformatics includes a six months project work in the thrust areas of specialization which is broadly classified into six categories keeping in mind the number of faculties present. First, is the Structural Biology and Bio - Computing where Molecular Biology concepts such as Protein Cloning, Expression, Purification and Crystallization are performed to work on the isolation of the desired protein where the structural and functional characteristics that are yet to be explored. Hence,

through X-ray Crystallography one can deduce the same and collect the insight details based on these inputs computational studies such as screening, molecular dynamics simulation, quantum based approaches, structure based drug design, QSAR etc (Drug Discovery and Design, CADD & Structural Bioinformatics) are performed to identify suitable leads from commercial/natural sources for a disease – associated targets. Either way, leads identified by targeting the molecular fingerprints of an individual known as Personalized medicine (Pharmacogenomics & CADD) as this sought to be the most preferred, selected and specific approaches by the Pharma related Industries to further validate the compounds with the aid of assay to estimate its inhibitory potential against that target conferring to life-threatening diseases such as cancer, TB, Diabetes, HIV, Inference of Vitamin D – Deficiency on population through genetic studies, Implications of *Vibrio* species to the aquaculture residential species by the application of phage therapy. Additionally, these collected inputs such as the availability of different targets in association in many pathways (cross-talk), established compounds based on experimental evidences either commercially or from natural sources (Isolation from plants that is claimed to have therapeutic significance) is well collected, documented and maintained in the form of databases and also the information that are collected from several sources are also included. Thus, the scholars can frame their thesis based on these areas mentioned above along with updated working of methodologies within the stipulated period of time.

Reference/Text Books:

As per the area of study taken

Course Objectives: To make the students:

- Demonstrate knowledge and understanding of the molecular machinery of living cells.
- Demonstrate knowledge and understanding of the principles and basic mechanisms of the research area.
- Use basic laboratory skills and apparatus to obtain reproducible data from biochemical experiments.
- Implement experimental protocols, and adapt them to plan and carry out simple investigations.

Course Outcomes: The student shall be able to:

- Analyze, interpret, and participate in reporting to their peers on the results of their laboratory experiments.
- Participate in and report orally on team work investigations of problem-based assignments.
- Build on their knowledge and understanding in tackling more advanced and specialized courses, and more widely to pursue independent, self-directed and critical learning.
- Formulate hypotheses based on current concepts in the field and design, conduct, and interpret their own research projects.
- Present research results in peer-reviewed publications and in a dissertation.
- Communicate research results effectively through oral presentations at scientific seminars, conferences, and other venues.
- Write a competitive application for research funding.
- Develop ancillary skills, where necessary, to obtain positions outside of scientific research.

Elective			
Course code: 502501	**General chemistry**	**Credit:5**	**Hrs: 5**
Objectives	➢ To learn about basic idea of aomaticity, organic synthesis, aliphatic nucleophilic substitution reactions, aromatic nucleophilic and electrophilic substitution reactions ➢ To understand the biological molecule present in the bio-organic and bio-inorganic compounds.		
Unit-1	**Aromaticity**: Concept of aromaticity, non-aromaticity and anti-aromaticity, Huckel's rule, annulenes, fulvenes. **Organic Synthesis**: Synthesis of alcohols, phenols, aldehydes and ketones. **Heterocyclic Compound**: Synthesis of aromatic heterocyclic compounds. Synthesis of five membered ring compounds: Pyrrole, Indole, Furan, Imidazole and Thiophene.		
Unit-2	**Nucleophiles and Electrophiles:** Definition of Nucleophilic and Electrophilic Substitution reaction and mechanism of S_E1, S_E2, and S_Ei reaction. S_N1, S_N2, and S_Ni reaction with mechanism, neighboring group participation and leaving group.		
Unit-3	**Chemical Bonding**: Bond theory, hydrogen bonding, ionic bond, metallic bond, covalent bond, sigma bond, pi-bond, bond length, bond strength, delocalization, conjugation, resonance, hyperconjugation, and Vander-Waals forces. Free electron theory, Molecular orbital theory, conductor, insulators and semiconductors. **Acid base theory:** Arrhenius theory, acids and bases in protic solvents, Bronsted-Lowry theory, Lewis theory, acid-base strength, theoretical basis of hardness and softness, electronegativity.		
Unit-4	**Nano Chemistry:** Definition, One-Dimensional, Two-Dimensional and Three-Dimensional nanomaterials, stability, properties (nanowire, nanorod and nanotube), self assembly nanoparticles, Fundamentals of Drug Nanoparticles, combination of drugs with their drug delivery system. **Polymer chemistry:** Basic concepts of polymers, classification: Natural, synthetic, linear, cross linked, network, plastics, elastomers and fibres, **Pharmaceutical Chemistry:** Chemistry of antibiotics and related drugs with their mode of action and side effects (Benzathine penicillin, Ampicillin, cis-platin,-Chloroquine and Amodiaquine) Structure and uses of pharmaceutical polymers such as cyclodextrin, Ethyl cellulose, polymethacrylate, polyvinyl alcohol and polyvinyl pyrrolidone.		
Unit-5	**Bio-organic Chemistry:** Overview of Bio-organic Chemistry, interaction between Organic and Biological Chemistry, Chemical composition of Living Cells,Types of primary biological molecules, Steroids, Coenzymes: Structure and biological functions of Enzymes. **Bio-inorganic Chemistry:** Overview of Heme and Non-heme Proteins,Metal ions present in biological systems. Hemoglobin and Myoglobin, Hemerythrin and Hemocyanin, Bohr Effect, Structure and functions of Electron transfer proteins such as Iron-sulphur proteins (Ferrodoxins and Rubredoxin) and Cytochromes		

Reference and Text Books:

Agrawal, J. P., & Hodgson, R. D. (2007). *Organic chemistry of explosives* (pp. 142-143). Chichester, UK: John Wiley & Sons.

Ahuja, S., & Jespersen, N. (Eds.). (2006). *Modern instrumental analysis* (Vol. 47). Elsevier.

Atul, S. (2009). *The Pearson Guide to Objective Chemistry for the AIEEE.* Pearson Education India.

Bhattacharjee, M. K. (2016). *Chemistry of antibiotics and related drugs* (Vol. 8). Cham: Springer.

Bréchignac, C., Houdy, P., & Lahmani, M. (Eds.). (2008). *Nanomaterials and nanochemistry*.

<table>
<tr><td colspan="2">
Springer Science & Business Media.
Cammack, R. (1999). Iron-Sulfur Proteins. Academic Press.
Clayden, J., Greeves, N., Warren, S. (2012). Organic Chemistry (2nd ed.). OUP Oxford.
Eldik, R. V. (2004). Advances in Inorganic Chemistry. (Vol-55). Elsevier.
Gopalan, R. (2009). Inorganic chemistry for undergraduates. Universities Press.
Gowariker, V. R., Viswanathan, N. V., Jayadev Sreedhar, N. V. (2008). Polymer Science. (1st ed.). New Age International Pvt. Ltd.
House, J. E. (2012). Inorganic Chemistry (2nd ed.). Publisher-Academic Press.
Kaim, W., Schwederski, B., & Klein, A. (2013). Bioinorganic Chemistry--Inorganic Elements in the Chemistry of Life: An Introduction and Guide. John Wiley & Sons.
Lewis, A. (Ed.). (2009). Drug-device combination products: delivery technologies and applications. Elsevier.
McMurry, J. (2008). Organic Chemistry 7th Ed. Thomson Higher Education.
Thassu, D., Deleers, M., Pathak, Y. (2007). Nanoparticulate Drug Delivery Systems. Edition-Informa Healthcare USA, Inc.
Watson, D. G. (2011). Pharmaceutical Chemistry E-Book. Publisher-Elsevier Health Sciences.
</td></tr>
<tr><td>Outcomes:</td><td>➢ The student will be able to gaining the reaction mechanism and concept of basic bonding theory.
➢ The student shall understand the basic pharmaceutical polymer and nano chemistry.</td></tr>
</table>

Elective			
Course Code: 502502	**Fundamentals of Computing**	**Credits:**	**Hours:**
Objectives	➢ Identify types of computers, how they process information and how individual computers interact with other computing systems, devices and the function of computer hardware components ➢ Identify how to maintain computer equipment and solve common problems relating to computer hardware		
Unit-I	**Overview and Organization of a Computer**: Computer system, storage, devices, memory, etc, Types of Processing: Batch, Real-Time, Online, Offline, Types of modern computers: The workstation, The Minicomputer, Mainframe Computers, Parallel Processing Computer, The Super Computer, etc		
Unit-II	**Software Concepts**: Concepts of flowcharting, Algorithm development, Relationship between hardware and software, Types of software: System software and Application software. **Operating Systems:** Introduction, Process management, Memory management, File management, Device management and Security. Introduction to Windows/Unix/Linux		
Unit-III	**Computer Networking:** OSI Reference Model, topologies and protocols, designing networks, Networking gadgets (Router, Switch, etc); Data Communication (ISDN, VPN, DSL, cable modem, cellular modem, etc); Communication Links (Wire pairs, Coaxial cables, Fiber optics, Microwave, Satellite, etc).		
Unit-IV	**Data Security:** Data security fundamentals: types of attacks, firewall, packet filtering, classification of data security threats, protection mechanism (authentication, access control and access rules), Encryption/Decryptions techniques, An overview of Computer viruses: How do they get transmitted? What are the dangers? General Precautions to be taken, Current & future technologies (Grid Computing, VPN, wireless, mobile computing, biometrics etc.		
Unit-V	**Internet:** The Internet and its Resources, Internet protocols, services, and related terminologies. Web browsers, customizing browsers, Blocking popup windows, Internet programming languages.		

Reference and Text Books:-

Andrew S. Tanenbaum & David J. Wetherall. (2012). *Computer Network*. Pearson Educations.

Briere, D., Hurley, P., & Ferris, E. (2011). *Wireless home networking for dummies*. John Wiley & Sons

Dromey, R.G. (2007). *How to Solve it by Computer*. Pearson Education.

Frye, C., & Frye, C. (2003). *Microsoft Office Excel 2003 step by step* (pp. 1-20). Redmond, WA: Microsoft Press.

Godse, D.A. & Godse, A. P. (2006). Computer Organization and Architecture. Technical Publications.

ITL Education Solutions Limited. (2011). *Introduction to Computer Science, 2/e*. Pearson Education India.

John, R., Young, M.L & Baroudi, C. (2007).*The Internet for Dummies*. Willy Publishing Inc.

Leon, A., & Leon, M. (2000). Introduction to Computers. Vikas Publishing House.

Levine, J. R., & Young, M. L. (2010). *The Internet For Dummies*®. John Wiley & Sons.

McNab, C. (2007). *Network security assessment: know your network*. "O'Reilly Media, Inc.".

Rajaraman, V., & Adabala, N. (2014). *Fundamentals of computers*. PHI Learning Pvt. Ltd...

Vitek, J., & Jensen, C. D. (Eds.). (1999). *Secure Internet programming: security issues for mobile and distributed objects*. Springer Science & Business Media.	
Outcomes	➢ To understand the basics of computer system, its architecture, database and networks. ➢ To understand the basic concepts, terminology of computer science and familiar with the use of IT tools.

Elective			
Course Code: 502503	**IPR, Bio-safety and Bioethics**	**Credits:**	**Hours :**

Objectives	➢ Get a holistic understanding of the complexities involved in the process of featuring intellectual property rights to people. ➢ Learn the legalities of intellectual property to avoid plagiarism and other IPR relates crimes like copyright infringements, etc.
Unit - I	**Concept and Role of International Institutions:** Introduction of IPR, General Agreement on Trade and Tariff (GATT) and World Trade Organizations. Establishment and functions of GATT, World Trade Organization (WTO) and World International Property Organization (WIPO). WTO Summits, Role of Integrated Business Solution Center (IBSC) and Review Committee on Genetic Manipulation (RCGM), Production of Plant variety and formers right act.
Unit - II	**Patent and Copyright:** TRIPS, Different types of intellectual property rights (IPR), Patents, Trade mark, Trade secret copy right, Geographical distribution on biological diversity, Obligations, Production of Traditional Knowledge, Impact of GM Crops and GM Foods.
Unit - III	**Patent Law**: Patent application, Rules governing patents, Licensing □ Flavr Savr™ tomato as a model case. Case studies on patents (Basmati rice, Turmeric, Neem, etc.). Indian Patent Act, 1970. Benefits of transgenic plants and animals.
Unit - IV	**Intellectual property in Biotechnology:** Introduction and different levels of biosafety, Microorganism according to pathogenecity, rDNA research in India, General guidelines for research in transgenic plants, Good Laboratory Practices (GLP). Containments□ Types, National biosafety policies and law, Germplasm conservation and Cross border movement.
Unit-V	**Bioethics:** Introduction of bioethics, General ethical issues related to environmental release of transgenic plants, animals and microorganisms, Ethical issues related to embryonic stem cells, Genetic testing and screening, human clinical trials and drug testing.

Reference and Textbooks:-

Goel, D., & Parashar, S. (2013). *IPR, Biosafety and Bioethics*. Pearson Education India

Krishna, V. S. (2007). *Bioethics and biosafety in biotechnology*. New Age International.

Manju, P. (2013). *An Introduction to Intellectual Property Rights*, Cambridge: New India Publishing Agency.

Narayanan, P. (1998). *Patent La (3rd ed.)*. Eastern Law House Publisher.

Neeraj, P., Khushdeep, D. (2014). *Intellectual Property Rights,* PHI Learning Pvt. Ltd. New Delhi.

Sateesh, M. K. (2008). *Bioethics and biosafety*. IK International Pvt Ltd..

Outcomes	➢ Understand the principles, function and basic legal rules of IP Law. ➢ Recognize the relevant criteria for generating and protecting intellectual works.

<table>
<tr><td colspan="4">Elective</td></tr>
<tr><td colspan="2">Course code: 502504</td><td>Biosensor</td><td>Credits:</td><td>Hrs:</td></tr>
<tr><td>Objectives</td><td colspan="4">➢ To facilitate the student to attain skills in biological sensor and biomedical research application.
➢ To demonstrate the knowledge and understand the living cells, enzyme antibodies using electrical response.</td></tr>
<tr><td>Unit-I</td><td colspan="4">Sensor: Introduction and classification, history, principles of physical and chemical, mechanism of mechanical, electrical, thermal, magnetic, optical and chemical sensors. Medical diagnostic and environmental monitoring applications.</td></tr>
<tr><td>Unit-II</td><td colspan="4">Biosensor: Definition, Introduction of Avidin-Biotin mediated biosensor, immobilization of enzyme through the Avidin-Biotin modified system, microbial, biological oxygen demand biosensor, Luminescent and Glucose biosensors.</td></tr>
<tr><td>Unit-III</td><td colspan="4">Nanomaterials based Biosensor: Introduction and challenges of biosensor. Nanomaterials and nanodevices, nanocrystalline and carbon nanotube based biosensor.</td></tr>
<tr><td>Unit-IV</td><td colspan="4">Medical Biosensor: Introduction to biosensors for medical applications. Types: wearable sensor, temperature sensors, mechanical sensors, electrical sensors, biosensor for drug testing and discovery. Electrochemical DNA biosensor.</td></tr>
<tr><td>Unit-V</td><td colspan="4">Enzyme based Biosensor: Urea, single enzyme, mutable enzyme, organic phase enzyme, biotanical and yeast based biosensors. Theory of enzyme biocatalysis, enzyme immobilization technique, boold glucose monitoring.</td></tr>
<tr><td colspan="5">Reference /Text Book
Buerk, D. G. (2014). Biosensors: Theory and applications. CRC Press.
Coulet, P. R., & Blum, L. J. (Eds.). (2019). Biosensor principles and applications. CRC Press.
Lederberg, J. (2000). Encyclopedia of microbiology, four-volume set. Academic Press.
Li., J. &Wu., N. (2013). Biosensors Based on Nanomaterials and Nanodevices. CRC press.
Mulchandani, A. & Rogers., K. (2010). Enzyme and Microbial Biosensors: Techniques and Protocols. Humana Press.
S. Higson, (2012). Biosensors for Medical Applications. Elsevier.
Vetelino, J., & Reghu, A. (2017). Introduction to sensors. CRC press.</td></tr>
<tr><td>Outcome</td><td colspan="4">➢ Students can understand the biomedical application by using sensor material.
➢ Students can utilize the research knowledge of health care systemusing biological sensors.</td></tr>
</table>

<table>
<tr><th colspan="4">Elective</th></tr>
<tr><td>Course Code: 502505</td><td>Molecular Interactions</td><td>Credits:</td><td>Hours :</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To explain how ionic, hydrophobic, and hydrogen bonding interactions influence the molecular pattern of Biological processes - comprehend the underlying mechanisms and its associated action
➢ To determine the structure of nucleic acids and proteins and modulate accordingly the binding specificity between them.
➢ To distinguish different molecular biology techniques that are used to isolate, separate, and probe for specific proteins, nucleic acids, and intra molecular interactions.</td></tr>
<tr><td>Unit - I</td><td colspan="3">Fundamentals of atomic and molecular orbitals: Theory of atomic and molecular orbitals; Linear combination of atomic orbitals; Quantitative treatment of valency bond theory and molecular orbital theory; Resonance structures.</td></tr>
<tr><td>Unit - II</td><td colspan="3">Fundamentals of chemical bonding and non-bonding interactions: Electrovalent bond, stability of electrovalent bond. Covalent bond – partial ionic character of covalent bonds. Shape of orbitals and hybridization. Coordination bonds, Metallic bond. Molecular geometry-VSEPR Theory, hydrophobic interactions, electrostatic interactions, van der Waals interactions, hydrogen bonds.</td></tr>
<tr><td>Unit - III</td><td colspan="3">Protein Folding and stability: Factors determining protein folds- Helices, strands, turns, loops, disulphide bridge. Principles of protein folding, mechanism for protein folding, role of chaperons, Factors determining protein stability</td></tr>
<tr><td>Unit - IV</td><td colspan="3">Molecular interactions: protein-protein, protein-DNA, DNA-Drug, Protein-Lipid, Protein-Ligand, Protein-Carbohydrate interaction, metal coordination in metalloproteins, Inter and intra molecular interactions</td></tr>
<tr><td>Unit-V</td><td colspan="3">Experimental and Computational methods: Principles, Theory, Instrumentation and Application of ITC, SPR, Fluorescence techniques to bimolecular interactions. Databases and tools like DIP, INTACT etc.,</td></tr>
<tr><td colspan="4">Reference and Textbooks:-
Winter, M.J. (2016). Chemical Bonding. New York: Oxford University Press.
Meyerkord, C.L. & Fu, H. (2015). Protein-Protein Interactions: Methods and Applications (2nd ed.). Humana Press.
Kangueane, P. (2011). Protein-Protein Interactions. Nova science Publishers.
Mathura, V.S. & Kangueane, P. (2009). Bioinformatics: A Concept-Based Introduction. Springer.
Bujnicki, J.M. (2009). Prediction of Protein Structures, Functions, and Interactions. John Wiley & Sons Ltd.</td></tr>
<tr><td>Outcomes</td><td colspan="3">➢ How changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
➢ Connection between the sequence and the subcomponents of a biological polymer and its properties.
➢ Explanations based on evidence of how variation in molecular units provides cells with a wider range of functions.</td></tr>
</table>

ELECTIVE			
Course Code: 502506	**INTRODUCTION TO NEURAL NETWORKS**	**Credits:**	**Hours:**

Objectives	➢ To introduce the neural networks for classification and regression. ➢ To give design methodologies for artificial neural networks and to offer neural network implementations in Mat lab.
Unit-I	**Introduction to Neural Networks**: History, Biological Neurons and Neural Networks. Artificial Intelligence (AI) - Artificial Neurons, Networks of Artificial Neurons, Single Layer Perceptrons, Artificial Neural Networks (ANN)
Unit-II	**Learning and Generalization in Single Layer Perceptions**: Hebbian Learning. Gradient Descent Learning, The Generalized Delta Rule. Practical Considerations. Learning in Multi-Layer Perceptrons. Back-Propagation, Learning with Momentum. Conjugate Gradient Learning.
Unit-III	**Bias and Variance**: Under-Fitting and Over-Fitting, Improving Generalization.
Unit-IV	**Applications of Multi-Layer Perceptrons**: Radial Basis Function Networks: Introduction, Radial Basis Function Networks: Algorithms and Applications, Committee Machines.
Unit-V	**Self Organizing Maps**: Fundamentals, Self Organizing Maps: Algorithms and Applications, Learning Vector Quantisation, Overview of More Advanced Topics.

Reference and Text Books:-

Albrecht, R. F., Reeves, C. R., & Steele, N. C. (Eds.). (2012). *Artificial neural nets and genetic algorithms: proceedings of the International conference in Innsbruck, Austria, 1993*. Springer Science & Business Media.

Bishop, C. M. (2013). *Pattern recognition and machine learning*. springer.

Daniel, G. (2013). *Principles of Artificial Neural Networks*. World Scientific Publishing Co. Pt. Ltd.

Duda, R. O., Hart, P. E., & Stork, D. G. (2012). *Pattern classification*. John Wiley & Sons.

Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. MIT press.

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning* (Vol. 112, p. 18). New York: springer

Rojas, R. (2013). *Neural networks: a systematic introduction*. Springer Science & Business Media.

Outcomes	➢ Introduce the main fundamental principles and techniques of neural network systems. And design single and multi-layer feed-forward neural networks. ➢ Develop and train radial-basis function networks.

ELECTIVE			
Course Code: 502507	**Data Warehousing and Data Mining**	**Credits:**	**Hours:**
Objectives	➢ To introduce students to the basic concepts and techniques of Data mining and Data Warehousing. ➢ To develop skills of using recent data mining software for solving practical problems		
Unit-I	**Overview and Concepts**: Need for data warehousing, Basic elements of data warehousing, Planning and Requirements: Project planning and management, Collecting the requirements. Architecture And Infrastructure: Architectural components, Infrastructure and metadata.		
Unit-II	**Data Design And Data Representation**: Principles of dimensional modeling, Dimensional modeling advanced topics, data extraction, transformation and loading, data quality. Information Access and Delivery: Matching information to classes of users, OLAP in data warehouse, Data warehousing and the web. Implementation and Maintenance: Physical design process, data warehouse deployment, growth and maintenance.		
Unit-III	**Introduction**: Basics of data mining, related concepts, Data mining techniques. Data Mining Algorithms: Classification, Clustering, Association rules. Knowledge Discovery: KDD Process. Web Mining: Web Content Mining, Web Structure Mining, Web Usage mining.		
Unit-IV	**Advanced Topics**: Spatial mining, temporal mining. Visualization : Data generalization and summarization-based characterization, Analytical characterization: analysis of attribute relevance, Mining class comparisons: Discriminating between different classes, Mining descriptive statistical measures in large databases Data Mining Primitives, Languages, and System Architectures: Data mining primitives, Query language, Designing GUI based on a data mining query language.		
Unit-V	**DBMS**: Introduction, overview and types. Relational and transactional Database. Relational database-Introduction to relational DB, Data Definition-Manipulation-control-Objects, Views, sequences and Synonyms. Data Abstraction; Data Models; Instances & Schemes; E-R Model - Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables. Network Data Model: Basic concepts; Hierarchical Data Model: Basic Concepts; Multimedia Databases - Basic Concepts and Applications; Indexing and Hashing; Text Databases; Introduction to Distributed Database Processing, Data Security. ORACLE and SQL- introduction and functions in DBMS; SYBASE		

Reference and Text Books:-

Berry, M. W., & Kogan, J. (Eds.). (2010). *Text mining: applications and theory*. John Wiley & Sons.

Dunham, M.H. (2006). *Data Mining Introductory and Advanced Topics*. Pearson Education.

Feldman, R & Sanger, J. (2007). *The Text Mining Handbook: Advanced approaches in analyzing unstructured data*. Cambridge University Press.

Han, J., Kamber, M., & Pei, J. (2011). *Data mining concepts and techniques third edition*. The Morgan Kaufmann Series in Data Management Systems, 83-124.

Hu, X., & Pan, Y. (Eds.). (2007). *Knowledge discovery in bioinformatics: techniques, methods, and applications* (Vol. 5). John Wiley & Sons.

Inmon, W. H. (2005). *Building the data warehouse*. John wiley & sons.

Mallach Efrem, G. (2002). Decision Support and Data Warehouse System. *Tata McGrawHill*, 424-456.

Ross, M., & Kimball, R. (2013). *The data warehouse toolkit: the complete guide to dimensional*

modeling. Wiley. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). *Data Mining: Practical machine learning tools and techniques*. Morgan Kaufmann.	
Outcomes	➢ Understand data mining principles and techniques: Introduce DM as a cutting edge business intelligence method and acquaint. ➢ To understand concepts of Data warehousing, components of data warehousing and design schemas

ELECTIVE			
Course Code:502508	**Programming in C and C++**	**Credits:**	**Hours:**
Objectives	➢ To learn the fundamental programming concepts and methodologies which are essential to building good C/C++ programs. ➢ To practice the fundamental programming methodologies in the C/C++ programming language via laboratory experiences.		
Unit-I	**Basics of C**:Essentials of C Programs, Data Types and names in C, Reading and Writing to Standard input and output (I/O).Statements, Expressions, Operators, Hierarchy of operators, Control statements including decision, loops and branching. Loop control structures.		
Unit-II	**Arrays, Functions and Pointers**:Array initialization, 1D and 2D Arrays, Functions in C, Passing elements to functions, Scope and Storage Classes in C, Introduction to Pointers, Pointer notations, Applying Pointers, Allocating Memory, More Data Types, Storage classes, C preprocessor.		
Unit-III	**Structure & Unions**: Collecting Data Items of Different Types, Unions: Another Way to Collect Dissimilar Data, File input and output operations. Standard functions in the 'C' graphics module.		
Unit-IV	**Introduction to C++:** Object oriented programming concepts- inheritance, polymorphism, and encapsulation. Error handling, Exception handling, Memory management, Files I/O.		
Unit-V	**C and C++ programs for Bioinformatics applications programs**: Convert a DNA sequence to RNA sequence, Convert a RNA sequence to Protein sequence, Count the nucleotides of a DNA sequence using Loop, Count the amino acids in a protein sequence, find stop codon position in a given sequence, find a given pattern in sequences, find mismatches between two sequences of same length, Pass the value to a function using pointer, Convert NCBI format file to fasta sequence file, Find GC content using Structures in C.		

Reference and Text Books:-

Balagurusamy, E. (2017). *Programming in ANSI C*. Tata McGraw- Hill Education.

Barr, M. (1999). *Programming embedded systems in C and C++*. "O'Reilly Media, Inc.".

Gookin, D. (2004). *C for Dummies*. John Wiley & Sons.

Jana, D. (2014). *C++ and Object-Oriented Programming Paradigm.* PHI Learning Pvt. Ltd...

Kanetkar, Y. P. (2005). *Let us C+*. BPB publications.

Kernighan, B. W., & Ritchie, D. M. (2006). *The C programming language*.

Liang, Y. D. (2011). *Introduction to Programming with C++*. Pearson Education India.

Liang, Y. D. (2011). *Introduction to Programming with C++*. Pearson Education India.

Liberty, J., & Jones, B. L. (2004). *Sams teach yourself C++ in 21 days*. Sams publishing.

Marshall, A. D. (1999). Programming in C, Unix system calls and subroutines using C, chapter IPC: Shared memory.

Moret, P. (2006). Algorithms in Bioinformatics. In *6th international workshop, WABI.*

Parthasarathy, S. (2008). *Essentials of C Programming for Life Sciences.* Ane's Books India, New Delhi.

Scheldt, H. (2009). *C++: The Complete Reference.*Tata McGraw- Hill Education.

Outcomes	➢ Program with pointers and arrays, perform pointer arithmetic, and use the pre-processor. Be able to write programs that perform explicit memory management.

	➢ Understand how to write and use functions, how the stack is used to implement function calls, and parameter passing options.

Elective			
Course Code: 502509	**Cell Communication and Cell Signaling**	**Credits:**	**Hours:**

Objectives	➢ To understand the basic principles of signal transduction mechanisms, signal amplitude and duration, signal integration and intracellular location. ➢ To understand the examples of different types of extracellular signals and receptors, and explain their functional significances.
Unit – I	**Host parasite interaction:** Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.
Unit – II	**Cell signaling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemo taxis and quorum sensing.
Unit – III	**Cellular communication:** General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation and Regulation of hematopoiesis.
Unit – IV	**Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth. Pr med cell death, aging and senescence.
Unit-V	**Morphogenesis and organogenesis in animals:** Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination. **Morphogenesis and organogenesis in plants:** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum.*

Reference & Textbooks:

Bunz, F., (2016) *Principles of Cancer Genetics*. Springer.

Gilbert, S. F. (2013). *Developmental Biology, (10th ed.). Sunderland, MA: Sinauer Associates*.

Pfeffer, U. (Ed.). (2013). *Cancer genomics: molecular classification, prognosis and response prediction*. Springer Science & Business Media.

Raymond, W., Ruddon, Daniel, D., Loeb, (2007). *Cancer Biology ;*(4thed.) USA: OXFORD University Press.

Schulz, W. (2005). *Molecular biology of human cancers: an advanced student's textbook.* Springer Science & Business Media.

Outcomes	➢ The course aims at giving the student an overview of cellular interactions with the cellular microenvironment and the signaling events resulting from these interactions. ➢ Moreover, it will help the students to know about how the cells respond to physiological cues such as hormones and neuron signals.

Semester IV			
Course Code: 502510	**Big Data Analysis and Next Generation Sequencing**	**Credits: 2**	**Hours: 3**
Objectives	• To make students understand the use of R in Data representation, File Input/Output operations; Big Data Analysis and Next Generation Sequencing; • To provide the student with a strong foundation for principles, methods and concepts of sequencing, Impact of transcriptomics on biology • To create students opportunity to analyze the Big Data, NGS, Microarray, RNA-Seq of gene, lncRNA, siRNA		
Unit - I	**Unit-I** **R statistical package:** Essentials of R-Package and libraries, mathematical operations, string operations, Data structures: vectors, data frames, lists, matrices, Control loops: if, else, while for loops. File Input/Output operations. R plots and the graphics library. Overview of Statistical packages and bioconductor libraries in R. Data representation: Qualitative and quantitative data types, Tabulation and visual display of data, plotting line plot, scatter plot, frequency histograms, pie-chart, heat map and 3D plots.		
Unit - II	**Unit-II** **Concepts of Genomics/Epigenomics:** History of genomics; Genome projects of model organisms; Principle of Sanger's dideoxy method, Microarray and RNA-seq, Next Generation Sequencing technology, Different platforms of NGS, Overview of metagenomics principles, Methylation of DNA and genetics; histone modifications, ChIP-chip ChIP-seq- techniques. Impact of transcriptomics on biology, volume of data produced and important repositories.		
Unit - III	**Unit-III** **Transcriptome NGS/Big Data analysis:** Microarray data analysis: gene expression analysis, statistical methods; relative merits of various platforms. Mapping algorithms such as Burro-Wheeler. Measuring gene, lncRNA, siRNA from RNA-seq NGS data. Sequence assembly concepts and challenges in assembling short reads; Algorithms for assembling short reads using graph theory such as Hamiltonian cycle and de Brjin; Writing code for assembling reads. Gene prediction and annotation; gene ontology (GO); Genome-wide annotation methods; identification of synteny between various genomes and challenges.		
Unit - IV	**Unit-IV** **Variant Analysis and computational Epigenomics:** Identification genetic variants from genome sequence: SNPs, SNVs, translocation, copy number variation. Concepts behind genome-wide association studies. Introduction to various applications. Concepts and algorithms to measure transcriptional regulation; methylation and alternative splicing; relative merits of various approaches; small RNA analysis, validation of whole-genome database.		
Unit-V	**Unit- V** **Data Analysis Interpretation:** Gene expression analysis, Differential expression analysis, Allele-specific expression, Prioritizing genetic variants, Non-synonyms variants (SIFT, Polyphen), Synonyms variants, Regulatory variants, Statistical methods on rare variants, Statisitcal considerations, Hidden Markov model annotating histone markers, Cloud computing.		
Reference and Textbooks:- Mandoiu, I., & Zelikovsky, A. (2016). *Computational Methods for Next Generation Sequencing Data*			

Analysis. John Wiley & Sons. Peter, D. (2015). Introductory statistics with R (2nd ed.). Springer Science & Business Media. Teschendorff, A. E. (Ed.). (2015). *Computational and Statistical Epigenomics*. Springer Netherlands. Xiong, M. (2017). *Big data in omics and imaging: Association analysis*. Chapman and Hall/CRC. Ye, S. Q. (Ed.). (2016). *Big data analysis for bioinformatics and biomedical discoveries*. CRC Press.	
Outcomes	• The student will have the capacity to comprehend the ideas of Genome projects of model organisms , Next Generation Sequencing technology • The students will be able to demonstrate Microarray data analysis, Genome-wide annotation methods; identification of synteny between various genomes and challenges

<table>
<tr><th colspan="4">Elective</th></tr>
<tr><td colspan="2">Course Code: 502511</td><td>General Microbiology</td><td>Credits:5</td><td>Hours: 5</td></tr>
<tr><td>Objectives</td><td colspan="4">➢ To understand of the concepts and fundamental principles of microbiology and also the key features of the structure, growth, physiology and behavior of bacteria, viruses, fungi and protozoa.
➢ To learn the structural organization, morphology and reproduction of microbes and to know the principles of Microscopy and advancements in Microscopy.</td></tr>
<tr><td>Unit – I</td><td colspan="4">Overview of History of Microbiology: History and Scope of Microbiology – Generation theory – Contribution of Leuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister, Winogradsky, Waksman and John Tyndall. Classification of microorganisms - Haeckel's three kingdom concept, Whittaker's five kingdom concept, Carl Woes three domain system, Bacterial classification according to Bergey's manual of systemic Bacteriology.</td></tr>
<tr><td>Unit – II</td><td colspan="4">Morphology and Sub-cellular structures:Morphological types, Cell wall of Gram negative, Gram positive bacteria and halophiles. Cell wall synthesis. Capsule composition and function. Cell membranes in Eubacteria, archaebacteria and cyanobacteria, Cell membrane functions. Periplasmic space. Structure and function of flagella, cilia and pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes. Reserve food materials – polyhydroxybutyrate, polyphosphates, cyanophycin and sulphur inclusions. General account on mycolpasma.</td></tr>
<tr><td>Unit – III</td><td colspan="4">Basic concepts of eukaryotic microbes:General characteristics, Classification, Structure and Reproduction of Algae: Chlorophyta (Green algae), Diatoms, Rhodophyta (Red algae), Fungi: Cell wall – chemical composition and functions, membranes and their functions, nutritional strategies of fungi. Structure and life cycle of fungi Ascomycetes (Aspergillus), Zygomycetes (Mucor), Basidiomycetes (Agaricus) and Protozoa.</td></tr>
<tr><td>Unit – IV</td><td colspan="4">Basic concepts of virology: Discovery, distinctive properties, morphology and ultra-structure of Virus, Classification, Cultivation and Purification assay of virus. Bacteriophages- structural organization and life cycle - lytic, lysogenic. Viral related agents - viroid and prion.</td></tr>
<tr><td>Unit-V</td><td colspan="4">Microscopic Techniques: Principle and application of bright field, dark field, phase contrast, fluorescence, electron microscope- TEM and SEM, Polarized Microscope and Confocal Microscopy.</td></tr>
<tr><td colspan="5">Reference & Textbooks:
Dubey, R.C., & Maheswari, D.K., (2013). A text book of Microbiology; S. Chand and Company Ltd.
Funke, B. R., Tortora, G. J., & Case, C. L. (2016). Microbiology (5MB/6MB): Adapted from microbiology: an introduction. Pearson Education south Asia Pte Limited.
Prescott, L. M., Harley, J. P., & Klein, D. A. (2008). Microbiology, 2nd edn. Wm. C. Brown. Pub., New York, 224.
Sherwood, L., Willey, J. M., & Woolverton, C. (2011). Prescott's microbiology. McGraw-Hill.
Sherwood, L., Willey, J. M., & Woolverton, C. (2014). Prescott's microbiology. McGraw-Hill.</td></tr>
<tr><td>Outcomes</td><td colspan="4">➢ Knowledge on historical perspective of Microbiology.
➢ Basic knowledge on different structure of microbes.
➢ Ideas on different type of microscope.</td></tr>
</table>

Elective			
Course code: 502512	**Open source in Bioinformatics**	**Credit:2**	**Hrs: 3**
Objectives	➢ Understand the outset of bioinformatics and its integration with diverse biological studies. ➢ Learn about the data generation like next generation sequencing, chemical structure drawing, microarray analysis, etc.		
Unit-1	**DNA and RNA sequence analysis:** Entrez, GenBank, EMBOSS, Artemis R11, Sequencher, DNA user, Jambw, GENSCAN, Glimmer, MUMmer, AUGUSTUS, RNA draw, RNA structure, Vienna RNA Package, RNA Family, CLC RNA Workbench.		
Unit-2	**Protein sequence analysis:** ExPASy Proteomics tools, AnthePro, PSAAM, Osprey, CLC Protein Workbench, WinPep, SubMito, ProteinVis, PIVOT, SOPMA, SIPMA, PSIPRED, PSORTb, Biological Networks, Predict Protein, SCRATCH, and Introduction to Bioubuntu.		
Unit-3	**Molecular biology, Sequence alignment and Phylogeny:** NetPrimer, PerlPrimer, SimVector, CGView, BioEdit, BioCococa, Readseq, PAUP, Phylip, TreeView, Sequence Manipulation Suite, MEGA, NJplot, TCoffee, PHYML.		
Unit-4	**Molecular modeling:** Docking study: Hex, Auto dock, Argus lab. RasMol, VMD, MolMol, CN3D, DTMM, Swiss-PdbViewer, gopenmol, StrukEd, JMVC, OscailX, ICM Browser, Gromacs, BioInfo3D, MODELLER, Chimera.		
Unit-5	**Chemical drawing and Microarray analysis:** ChemSketch, ChemDraw, BKChem, ScanAnalyze, Cluster, Cytoscape, dchip, SAM, DAVID Bioinformatics EASE, TM4, Pathway Explorer, Bioconductor.		

Reference and Text Books:

Baxevanis, A. D., & Ouellette, B. F. (2004). *Bioinformatics: a practical guide to the analysis of genes and proteins* (Vol. 43). John Wiley & Sons.

Droogmans, L., Grosjean, H., Purushothaman, S. K., & Lapeyre, B. (2004). *Practical Bioinformatics* (Vol. 15, pp. 139-168). J. M. Bujnicki (Ed.). Berlin: Springer.

Edwards, D., Stajich, J., & Hansen, D. (Eds.). (2009). *Bioinformatics: tools and applications*. Springer Science & Business Media.

http://autodock.scripps.edu/

http://www.arguslab.com/

http://www.bioinformatics.org/sms2/

http://www.loria.fr/~ritchied/hex/

Korpelainen, E., Tuimala, J., Somervuo, P., Huss, M., & Wong, G. (2014). *RNA-seq data analysis: a practical approach*. Chapman and Hall/CRC.

Mandoiu, I., & Zelikovsky, A. (2016). *Computational Methods for Next Generation Sequencing Data Analysis*. John Wiley & Sons.

Mount, D. W. (2004). *Bioinformatics: sequence and genome analysis. 2nd* (Vol. 692). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. xii.

Pazos, F., & Chagoyen, M. (2015). Structures. In *Practical Protein Bioinformatics* (pp. 43-83). Springer, Cham.

Wong, L. (2004). *The Practical Bioinformatician*, World Scientific Publishing Co. Pre. Ltd.

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

Ye, S. Q. (Ed.). (2007). *Bioinformatics: a practical approach*. CRC Press.

Outcomes:	➢ To gain knowledge about tools and resources for drug discovery. ➢ To find out whether appropriate structural information exists, together with the use of structure-quality information.

Semester - IV			
Course Code: 502513	**Biodiversity, Agriculture, Ecosystem, Environment and Medicine**	**Credits:**	**Hours :**

Objectives	➢ Analyze the environment as a determinant of health, identify and analyze current environmental health problems and issues. ➢ Explain the social-scientific basis and process for developing natural resources and environmental health policies and management practices. ➢ Interpret and apply environmental and natural resources policies and management principles/approaches to a variety of case-specific environmental health problems.
Unit - I	**Biodiversity:** Status, scope, types, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Uses of Biodiversity, Loss of biodiversity, Biotechnology information: Management and Communication, Libraries, Bibliographies, Periodicals, Databases, Distribution of biodiversity information, Metadatabases, Virtual libraries, Special interest networks, Biodiversity Application Software – CD□ROMs and Diskettes.
Unit - II	**Agriculture:** Crops: Comparative genomes of plant and model plants, Insect resistance, Improve nutritional quality, Grow drought resistant crops in poorer soils, Biodiversity of Indian medicinal plants. **Ecosystem:** Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
Unit - III	**Ecosystem:** Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).**Conservation Biology:** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).
Unit - IV	**Environment:** Waste cleanup: Superbugs and their concept, Microbes and Climate change, Alternative energy sources and Fuel cells. Biotechnological applications of microbes, Antibiotic resistance, Forensic analysis of microbes, the reality of bioweapon, Metagenomics.
Unit-V	**Medicine:** Gene therapy Fundamentals of gene therapy, Gene therapy present and future, clinical trials. Applications of Bioinformatics in cancer detection, Drug targets, Human genome diversity

Reference and Textbooks:-

Dahiya., P,& Ahlawat, M. (2013*). Environmental Science: A New Approach.*Alpha Science**.**

Fulekar, M. H. (Ed.). (2009). *Bioinformatics: applications in life and environmental sciences*. Springer Science & Business Media.

Saha., T.K. (2013). *Ecology and Environmental Biology. Books & Allied* (P) Ltd.

Singh, J. S., Gupta, S. R., & Singh, S. P. (2006). *Ecology environment and resource conservation.* Anamaya Publishers.

Tandon, P., Abrol, Y. P., & Kumaria, S. (Eds.). (2007). *Biodiversity and its significance*. IK International Pvt Ltd.

Outcomes	➢ Describe major social, cultural, and bio-behavioral patterns of health and health behavior in community settings. ➢ Portray basic research from epidemiology and public health on leading health conditions. ➢ A good understanding of inter-relationship between climate change,

	environment, food security and sustainability at global and regional (India) level.

NON MAJOR ELECTIVES

Non Major Elective			
Course code: 533704	Nanotechnology and Advanced drug delivery system	**Credit:2**	**Hrs: 3**
Objective	➢ To gain the knowledge about the nanocarriers used for drug delivery system. ➢ To know the application of Nanomedicine in cancer therapy.		
Unit-I	**Basic concepts of Nano-science and technology:** Properties and technological advantages of Nanomaterials - Quantum wire, Quantum well, Quantum dots and Carbon nanotubes : Synthesis – Top down and bottom up approaches; Characterization - Spectroscopic techniques and Microscopic observations.		
Unit-II	**Fundamentals and types of Nanocarriers:** Types - Viral nanocarrriers, Polymeric nanocarrier, lipid nanocarrier, carbon nanostructures, dendrimers, silica nanoparticles, Microbes and antibody based nanocarriers; Physicochemical properties - Size, Surface, Magnetic and Optical Properties.		
Unit-III	**Nanotechnology for Drug Targeting** Drug targeting – Targeted (Microneedles, Micropumps, microvalves, Implantable microchips), non-targeted delivery, controlled drug release; Nanoparticle surface modification – bioconjugation, peglyation, antibodies cell- surface targeting; nanostructures for use as antibiotics, diseased tissue destruction using nanoparticles, drug encapsulation strategies.		
Unit-IV	**Nanotechnology for Imaging and Detection** Fluorophores and Quantum dots - Labeling and functionalization, Image analysis, Imaging facilitating surgical approaches; Nanoparticles for bioanalytical applications – Biosensors - DNA and Protein based biosensors – materials for biosensor applications- fabrication of biosensors, BioMEMs; Use of nanoparticles for MRI, X Ray, Ultrasonography Drug Delivery; Nano devices.		
Unit-V	**Nanomedicine:** Nanotechnology in Cancer Therapy - Passive and Active Targeting Strategies in Cancer with a Focus on Nanotechnology Applications, Multifunctional Nanoparticles for Cancer Therapy - Neutron Capture Therapy of Cancer, nanoparticles and High Molecular Weight Boron Delivery Agents; Nanoneurology – Nanocardiology - Nano-Orthopedics - Nano-Ophthalmology.		

Reference and Text Books:

Bulte, J. W., & Modo, M. M. (2017). Nanoparticles as a technology platform for biomedical imaging. In *Design and Applications of Nanoparticles in Biomedical Imaging* (pp. 1-7). Springer, Cham.

Kumar, P., & Srivastava, R. (2016). *Nanomedicine for Cancer Therapy: From Chemotherapeutic to Hyperthermia-Based Therapy*. Springer.

Malhotra, B. D., & Ali, M. A. (2017). *Nanomaterials for Biosensors: Fundamentals and Applications*. William Andrew.

Mishra, V., Kesharwani, P., Amin, M. C. I. M., & Iyer, A. (Eds.). (2017). *Nanotechnology-Based Approaches for Targeting and Delivery of Drugs and Genes*. Academic Press.

Mohapatra S.S., Ranjan S., Dasgupta N.,&Mishra R.K. (2019*).Nanocarriers for drugdelivery, Nanoscience and Nanotechnology in drug delivery*. Elseiver.

Nikolelis, D. P., & Nikoleli, G. P. (Eds.). (2018). *Nanotechnology and Biosensors*. Elsevier.

Shah, M. R., Imran, M., & Ullah, S. (2017). *Lipid-Based Nanocarriers for Drug Delivery and Diagnosis*. William Andrew.

Slevin, M. (2012). *Current Advances in the Medical Application of Nanotechnology*. Bentham Science Publishers.

<table>
<tr><td colspan="2">Varghese, T., & Balakrishna, K. M. (2012). Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials. Atlantic Publishers & Distributors.
Vo-Dinh, T. (2007). Nanotechnology in biology and medicine: methods, devices, and applications. CRC Press.</td></tr>
<tr><td>Outcomes:</td><td>➢ Students can able to know about nanotechnology for the drug targeting.
➢ Students can able to gain the knowledge for targeted and non-targeted drug delivery using nanocarriers.</td></tr>
</table>

Elective			
Course Code: 509203	**Immunology and Immunotechnology**	**Credits:2**	**Hours: 3**
Objectives	➢ This course includes a detailed description of the immune response made in humans to foreign antigens including microbial pathogens. ➢ To be able to compare and contrast humoral versus cell-mediated immune responses and to distinguish various cell types involved in immune responses and associated functions.		
Unit – I	**Introduction:** History and scope of Immunology, Tissues and organs of immune system - structure and function. Molecules of immune system - antibodies, complements, cytokines, interferons - types, sources and functions. Antigen: Classification, epitopes, antigen and antibody interaction.		
Unit – II	**Elements of immune system:** Hematopoiesis, T-cells, B-cells, myeloid cells, antigen presenting cells, cell mediated subset of T-Cells, helper and suppressor cells, cell medicated and humor immunity, antibody dependent cell mediated cytotoxicity, natural killer cells.		
Unit – III	**Innate and adaptive Immune response:** Innate, acquired, active and passive immunity - mechanism of humoral and cell mediated immune responses - immunity to infections - immunoprophylaxis, vaccines and immunization schedule. Immunological disorders.		
Unit – IV	**Disease & Immune response:** - Infectious diseases, hypersensitivity - Types I, II, III and IV; autoimmune disorder; immunodeficiency diseases. Tumor and transplantation immunology - major histocompatibility complex (MHC), immunotherapy for the treatment of cancer.		
Unit-V	**Immune techniques:** Immunocytochemistry, Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, Acquired Immuno Deficiency Syndrome (AIDS) test, hybridoma technology, radioimmuno assay.		
Reference & Textbooks: Abbas, A. K., Lichtman, A. H., & Pillai, S. (2017). *Cellular and molecular immunology E-book.* Elsevier Health Sciences. Annadurai, B., (2017). *A Textbook of Immunology &Immunotechnology.* S Chand & Company. Kannan, I. (2013). *Immunology*: MJP Publication. Levinson, W. E. (2016). *Review of Medical Microbiology and Immunology 14E*. McGraw Hill Professional. Vaman Rao., (2016). *Immunology*. New Delhi: Narosa Publishing House Pvt, Ltd.			
Outcomes	**Outcomes:** ➢ Students can understand the structure and function at the molecular and cellular level of the immune defense. ➢ Students will be able to describe immunological response and how it is triggered and regulated.		

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Educational Qualification

- ✓ Ph.D (Crystallography and Biophysics) from CAS in Crystallography & Biophysics, University of Madras, Tamil Nadu, India (2000).
  Title: X-ray crystallographic studies on some organic compounds of medical and biological importance.
  Mentor: Prof. D. Velumurugan, Professor Emeritus, Former UGC-BSR faculty and Head, CAS in Crystallography & Biophysics, University of Madras, Tamil Nadu, India
- ✓ M.Phil (Physics) from M.K. University, Madurai (1995)
- ✓ M.Sc (Physics) from M.K. University, Madurai (1993)
- ✓ B.Ed (Physics) from University of Madras (1991)
- ✓ P.G. Diploma (Computer Application) from MIT, Anna University(1999)

Professional Experience

- ✓ Professor and Head in Department of Bioinformatics, Alagappa University, Karaikudi (Mar 2010-till date)
- ✓ Research Scientist, Spring-8, Japan (May2007-Mar2010)
- ✓ Researcher, RIKEN Harima Institute, Spring-8, Japan (Jun 2003-May2007)
- ✓ PDF, Indian Institute of Science, Bangalore (Jan 2000-May 2003)

Honours and Awards

- ✓ **LEAP2019** from the MHRD, Govt of India for training Senior Professors to next level academicians.
- ✓ **Research Award 2016** from the University Grants Commission, New Delhi, India (plus two year's salary)
- ✓ **Elected** Fellow for **The Academy of Sciences, Chennai**, India (**FASCh)** in 2015.
- ✓ **UGC-SAP Nominee** from the University Grants Commission, New Delhi to monitor and assess the effective implementation of SAP programme in Punjab University, Punjab (2015).
- ✓ **Vice-President –** Bioinformatics and Drug Discovery Society **(BIDDS), from** 2017 for three years.
- ✓ **Cited in "Marquis"-** Who's Who Scientific Directory (2007)
- ✓ **IRPHA, DST & DBT - Post Doctoral Fellowship** (2000-2003)
- ✓ **Young Scientist travel Grants** from **DST & UNESCO** (1999) and **IUCr Young Scientist Fellow** (1999)
- ✓ **CSIR - Senior Research Fellowship** (1997-2000)

Recent Publications

- ✓ Mutharasappan Nachiappan, Vitul Jain, Amit Sharma, Manickam Yogave &**J Jeyakanthan**. Structural and functional analysis of Glutaminyl-tRNA synthetase (TtGlnRS) from *Thermus thermophilus* HB8 and its complexes.*Int.J Bio Macromol*, 120; 1379-1386, 2018. (**IF:3.909**)
- ✓ Amala. M, Rajamanikandan. S, Prabhu. D, Surekha, K &**J Jeyakanthan**. Identification of Anti-filarial leads against Aspartate semialdehyde Dehydrogenase of Wolbachia endosymbiont of *Brugia malayi*: Combined Molecular Docking and Molecular Dynamics Approaches.*J Biomol Struct Dyn*. 2018, Vol. 37, 394-410, 2019. (**IF:3.10**)
- ✓ Santosh Kumar Chaudhary, Yuvaraj Iyyappan, Mohanapriya Elayappan, **J Jeyakanthan**& K. Sekar. Insights into product release dynamics through structural analyses of Thymidylate kinase.*Int J Biol Macromol*, 123, 637-647, 2019. (**IF: 3.909**)
- ✓ Jayashree Biswal, Jayaprakash Prajisha, Suresh K. Rayala, Ganesh Venkatraman, Poopandi Saritha, Raghu Rangaswamy &**J Jeyakanthan**. Identification of Pak1 inhibitors using water thermodynamic analysis. *J Biomol Struct Dyn*, Jan 20:1-19, 2019. (**IF:3.310**)
- ✓ Boomi P, Ganesan R.M, Poorani G, Gurumallesh Prabu H, Ravikumar S &**J Jeyakanthan**. Biological synergy of greener gold nanoparticles by using Coleus aromaticus leaf extract.*Mat, Sci & Eng*, 99; 202-210, 2019. (**IF:5.08**)
- ✓ Sudharsana S, Madhana Priya N, Prabhu D, **Jeyakanthan J**& Mohanapriya Arumugam Conformational insights into the inhibitory mechanism of phyto-compounds against SRC kinase family members implicated in psoriasis.*J Biomol Struct Dyn*, Apr 9:1-17, 2019. (**IF:3.310**)

- ✓ Nachiappan M, Jain V, Sharma A, Yogavel M & **Jeyakanthan J**. Conformational changes in Glutaminyl-tRNA synthetases upon binding of the substrates and analogs using molecular docking and molecular dynamics approaches.*J Biomol Struct Dyn*, May 30:1-15, 2019. (**IF: 3.310**).

Cumulative Impact Factor: **330.58,** Citations: **1146**, h-index: **17,** i10 index-**32**

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Educational Qualification

- ✓ Ph. D in Applied Chemistry from CSJM University, Kanpur from the period 2000 – 2004.
  Title : Quantum pharmacological studies on HIV-1 RT inhibitors
  Mentor : Dr. Arpita Yadav, Associate Professor, CSJM University, Kanpur.
- ✓ M.Sc (Life Sciences) from the institute of Life Sciences, CSJM University, Kanpur during the period 1998 – 2000.
- ✓ B.Sc (Zoology, Botany, Chemistry) from Chirst Church College, CSJM University, Kanpur, Uttar Pradesh (1998).

Professional Experience

- ✓ Professor (20.03.2015 – till date) ~4 years 4 months
- ✓ Associate Professor (20.03.2012 – 19.03.2015) ~3 years
- ✓ Reader (20.03.2009 – 19.03.2012) ~3 years
  Dept of Bioinformatics, Alagappa University, Karaikudi -630003, Tamilnadu, India
- ✓ Lecturer in CoE in Bioinformatics, School of Biotechnology, Madurai Kamaraj University (March, 2006 – March, 2009)
- ✓ Scientist II – Pharmacoinformatics Division, NIPER, Mohali (June, 2004 – March, 2006)

Honours and Awards

- ✓ **Biotech Research Society, India (BRSI) Fellow Award – 2018** from the Biotech Research Society, India.
- ✓ **ICMR Lala Ram Chand Kandhari Award**-2014 from the Indian council of Medical Research (ICMR), New Delhi, India.
- ✓ **Senior Scientist Award-2017** from the Association of Biotechnology and Pharmacy (ABAP), Hyderabad, Telangana, India.
- ✓ Elected Member for **The National Academy of Sciences, Allahabad**, India (**MNASc)** in May 2017.
- ✓ **Dr. P. Daisy Oration Award-2017** from Department of Zoology, Biotechnology and Bioinformatics, Holy Cross College, Tiruchirapalli, Tamil Nadu, India.
- ✓ Travel Awards from **CSIR, DBT, DST, and ICMR (Funding)**.

Recent Publications

- Gupta, K.K., **Singh, S.K.,** 2019. Cdk5: A main culprit in neuro degeneration. *International Journal of Neuroscience*, Doi: 10.1080/00207454.2019.1645142. (**Accepted**) **(IF – 1.852)**
- Rajavel, T., Banu, Priya, G., Suryanarayanan, V., **Singh, S.K.,** Pandima, Devi, K., 2019. Daucosterol disturbs redox homeostasis and elicits oxidative-stress mediated apoptosis in A549 cells via targeting thioredoxin reductase by a p53 dependent mechanism. *European Journal of Pharmacology*, 855, 112-123. **(IF –3.170)**
- Ali, M.A., Vuree, S., Goud, H., Hussain, T., Nayarisseri, A., **Singh, S.K.,** 2019. Identification of High affinity small molecules targeting Gamma Secretase for the treatment of Alzheimer's Disease. *Current topics in medicinal chemistry*, DOI : 10.2174/1568026619666190617155326. **(IF – 3.374)**
- Jeyakumar, M., Sathya, S., Gandhi, S., Tharra, P., Suryanarayanan, V., **Singh, S.K.,** Baire,B., Devi, K.P., 2019. α-bisabolol β-D-fucopyranoside as a potential modulator of β-Amyloid peptide induced neurotoxicity: an in vitro & in silico study. *Bioorganic Chemistry,* DOI: https://doi.org/10.1016/j.bioorg.2019.102935. **(IF –3.926)**
- **Singh, S.K.,** Nayarisseri, A., 2019. Functional Inhibition of VEGF and EGFR Suppressors in Cancer Treatment. *Current topics in medicinal chemistry*, 19 (3), pp. 178-179. **(IF – 3.374)**
- Choudhary, P., Chakdar, H., Singh, A., Kumar, S., **Singh, S.K.**, Aarthy, M., Goswani, S.K,, Srivastava, A.K., Saxena, A.K., 2019. Computational identification and antifungal bioassay reveals phytosterols as potential inhibitor of Alterna riaarborescens. *Journal of Biomolecular Structure and Dynamics*,21, pp.1-15**. (IF – 3.107)**
- Prabhu, S.V. and **Singh, S.K.**, 2019. E-pharmacophore-based screening of mGluR5 negative allosteric modulators for central nervous system disorder. *Computational biology and chemistry*, 78, pp.414-423. **(IF – 1.412)**
- Kumar, A., Liang, B., Aarthy, M., **Singh, S.K.**, Garg, N., Mysorekar, I.U. and Giri, R., 2018. Hydroxy chloroquine inhibits Zika virus NS2B-NS3 protease. *ACS Omega*, 3(12), pp.18132-18141. **(IF – 2.5)**

- **Cumulative Impact Factor :** 274.517,
- **Total Citation :** 1069,
- **h-index :** 18, **i-10 index :** 39

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Educational Qualification

- ✓ Ph. D in (Biomedical Genetics) from Department of Genetics, Dr. ALMPGIBMS, University of Madras, Taramani Campus, Chennai, Tamil Nadu, India (Sep1999 - Oct 2006).
  Title : ANGIOTENSINOGEN (AGT) gene polymorphisms in South Indian Hypertensives.
  Mentor : Prof. G. JAYARAMAN, Coordinator (Molecular Biology Programme) & Former Director IBMS.
  Department of Genetics, Dr. ALM PGIBMS, University of Madras, Chennai – 600 113, Tamil Nadu, India.
- ✓ M.Sc (Biomedical Genetics) from Department of Genetics, Dr. ALMPGIBMS, University of Madras,
  Taramani Campus, Chennai, Tamil Nadu, India (May1999)
- ✓ B.Sc (Zoology) from Jamal Mohamed College, Bharathidasan University, Tiruchirappalli, Tamilnadu (April 1996).
- ✓ PG Diploma in Computer Applications (PGDCA) From Bishop Heber College, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India (April 1999).

Professional Experience

- ✓ Assistant Professor (18.08.2008 – till date) ~10 years
  Dept of Bioinformatics, Alagappa University, Karaikudi -630003, Tamilnadu, India
- ✓ Scientist in- charge (March 08 – August 08)
- ✓ Post doctoral Research Associate and Instructor (March 07 – August 07)
  College of Pharmacy, Nova South-eastern University, Florida, USA-33328
- ✓ Lecturer (July 05 –February 07)
  Department of Biotechnology, Vels College of Science, Pallavaram, Chennai- 600117, Tamilnadu, India

Honours and Awards

1. Lady TATA Memorial Trust Junior scholarship (JRF) award 2001- 2003.
2. Defense Research & Development Organization / Defense Institute of Physiology & Allied Sciences Senior Research Fellow (SRF) 2004 -2005.
3. Qualified SLET (State Level Educational Testing) examination in the year of 1999 conducted by Bharathidasan University, Tiruchirappalli, Tamil Nadu.
4. Best Paper Award in Pharmaceutical & Medicinal Synthetic Chemistry by The Indian Pharmaceutical Association's Prof. M. L. Khorana Memorial Indian Journal of Pharmaceutical Sciences in the year 2013.
5. Received Best Poster award in National Conference on Recent Innovations in Biotechnology (18th April, 2016) Organized by Department of Biotechnology, Aarupadai Veedu Institute of Technology (AVIT), Kanchipuram, Tamil Nadu, India for the Poster Entitled "Identification of potential CYP24A1 inhibitors through E-Phamacophore mapping and Molecular docking and Dynamics study".
6. Member (Basic Medical Scientist – Internal), Institute Ethics Committee (Human Studies), Alagappa University.
7. Member, Institutional BioSafety Committee (IBSC), Alagappa University
8. Assistant Director for International Relations of Alagappa University, Karaikudi, India.

9. Best Paper Award in Pharmaceutical & Medicinal Synthetic Chemistry by The Indian Pharmaceutical Association's Prof. M. L. Khorana Memorial Indian Journal of Pharmaceutical Sciences in the year 2017.
10. Received best poster award in National Conference on "Recent Trends in Plant Sciences"(01-02, March, 2017), organized by Department of Botany, ST. Xavier's College, Palayamkottai, Tamil Nadu, India.
11. Recipient of Alagappa University prestigious research award "Alagappa Excellence Research Award for the year of 2018".
12. Appointed as a Distinguished Adjunct Faculty by invitation at Saveetha Dental College and Hospitals, Chennai from 10th January 2019.

Recent Publications

1. Kim TS, Hui G, Li J, Kalia VC, **Muthusamy K**, Sohng JK, Kim IW, Lee JK. Overcoming NADPH product inhibition improves D-sorbitol conversion to L-sorbose. Sci Rep. 2019 Jan 28;9(1):815. (IF: 4.122).
2. S.J. Carlus, I.S. Almuzaini, **M. Karthikeyan**, L. Loganathan, G.S. Al-Harbi, A.M. Abdallah, K.M. Al-Harbi. Next-generation sequencing identifies a homozygous mutation in ACADVL associated with pediatric familial dilated cardiomyopathy. Eur Rev Med Pharmacol Sci 2019; 23 (4): 1710-1721. (IF:2.387).
3. Debleena Guin, Jyoti Rani, Priyanka Singh, Shivangi Bora, Puneet Talwar, Sandeep Grover, **Karthikeyan Muthusamy**, K Satyamoorthy, C Adithan, S Ramachandran, Yasha Hasija, Ritushree Kukreti. Global Text Mining and Development of Pharmacogenomic Knowledge Resource for Precision Medicine.Frontiers in Pharmacology (Accepted)
4. Lakshmanan Loganathan, Krishnasamy Gopinath, Vadivel Murugan Sankaranarayanan, Ritushree Kukreti, Kannan Rajendran, Jung-Kul Lee, and **Karthikeyan Muthusamy**. Computational and Pharmacogenomic Insights on Hypertension Treatment: Rational Drug Design and Optimization Strategies. Current Drug Targets.

Cumulative Impact Factor: 138.91; Total Citations: 502; h-Index: 12; i10-index: 18

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Educational Qualification

- ✓ Ph. D in (Computer science) from Department of Computer Science and Engineering,Alagappa University,Karaikudi, Tamil Nadu, India (Feb 2008-Feb 20014).
  Title :A New Technique On Automatic Ontology Generation For Semantic Search System Using Data Mining Techniques.
  Mentor : Prof.E.Ramraj,Head of the Department.
  Department of Computer Science, Alagappa University, Karaikudi– 630003, Tamil Nadu, India.
- ✓ M.Tech(Information Technology)from,Department Information Technology,Sathyabama University,Chennai. (April 2010).
- ✓ M.Phil(Computer Science) form Department of Computer Science,alagappan University, Karaikudi– 630003, Tamil Nadu, India.(April 2007).
- ✓ M.Sc (Computer Science) from Department of Computer Science , S.R.M Arts & Science College,Kattankulathur, University of Madras, Chennai, Tamil Nadu, India (May2005).
- ✓ B.Sc (Computer Science) from Sri Saratha Niketan College for Women,Amaravathipudhur, Madhurai Kamaraj University, Madhuraii, Tamilnadu (April 2002).

Professional Experience

- ✓ Assistant Professor (31.08.2015– till date) ~4 years
  Dept of Bioinformatics, Alagappa University, Karaikudi -630003, Tamilnadu, India
- ✓ Teaching Assistant (August 2013 – April 2015) ~2 Years
  Dept of Alagappa University,Karaikudi-630003,Tamilnadu,India.
- ✓ Seniour Lecturer (June 2010–Jan 2011)~6Months
  Dept of Information Technology,Madha Institute of Engineering & Technology, Sadhanadhapuram,Chennai.
- ✓ Seniour Lecturer (August 2006–April 2010)~3.9 Years.
  Dept of Computer Science and Engineering, Jaya Engineering College, Thiruninravur, Chennai, Tamilnadu, India

Honours and Awards: Nil

Recent Publications

1. Mani panagal,Biruntha M,**Vidhyavathi RM**,Sivagurunathan P , Senthilkumar S. Dissecting the role f miR-21in different types of stroke.Gene. 2019,69;72(1):681. (IF:2.49).

2. E. Laxmi Lydia P. Krishna Kumar K. Shankar S. K. Lakshmanaprabu **R.M. Vidhyavathi** Andino Maseleno.Charismatic Document Clustering Through Novel K-Means Non-negative Matrix Factorization (KNMF) Algorithm Using Key Phrase Extraction. Parallel Programming,2018; 23 (4):1-19. (IF:0.876).
3. Shankar K ,Mohamed Elhoseny, Lakshmanaprabu S K , Ilayaraja M ,**Vidhyavathi RM** , Mohamed A., Elsoud ,Majid Alkhambashi. Optimal feature level fusion based ANFIS classifier for brain MRI image classification.Concurrency and Computation,2018;e4887:1-12.(IF:0.760).

Cumulative Impact Factor: 9.736; Total Citations:90; h-Index:04; i10-index: 03

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Email : jjsrbioinformatics2016@gmail.com

Educational Qualification

- ✓ Ph. D in (Biotechnology) , Department of Biotechnology, Bharathidasan University,Truchirappalli,Tamil Nadu, India - (November -2010).
  - Title : *In vitro* Regeneration, Hairy Root Culture and *Agrobacteriumtumefaciens*-Mediated Transformation in West Indian Gherkin (*Cucumis anguria* L.).
  - Mentor: Prof.A.Ganapathi, Professor and Head, Department of Biotechnology, Bharathidasan University, Truchirappalli, Tamil Nadu, India.
- ✓ M.Sc (Biotechnology), Department of Biotechnology, Bishop Heber College, Bharathidasan University, Truchirappalli,Tamil Nadu, India - (April – 2004).
- ✓ B.Sc (Biochemistry), Department of Biochemistry, Arputha College, Bharathidasan University, Truchirappalli,Tamil Nadu, India - (April – 2002).

Professional Experience

- ✓ Assistant Professor, Department of Bioinformatics, Alagappa University, Karaikudi -630003, Tamilnadu, India -(04.12.2015 – till date).
  Assistant Professor,Department of Biochemistry & Microbiology, RVS College of Arts and Science, Karaikkal, Pondicherry, India - (June -2010 to March - 2012)
- ✓ Assistant Professor,Department of General Engneering, St. Joseph's Group of Institution, Dar EsSalaam,Tanzania -(May -2012 to March - 2013).

Honours and Awards

1. Bharathidhasan university research fellowship (2006 – 2009)
2. Key Note Speaker Award –Gauhati University, Guwahati, India- 2019

Recent Publications

Recent Publication : Nil

Cumulative Impact Factor: 25.8; Total Citations: 80; h-Index: 03; i10-index: 02

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Educational Qualification

- ✓ Ph.D –Chemistry, Alagappa University, Karaikudi, September, 2014.

Title:Studies on Polyaniline with Mono and Bimetal Nanocomposites for Antibacterial and Anticancer Applications.

Mentor : Prof. H. Gurumallesh Prabu, Professor, Department of Industrial Chemistry, Algappa Universisty, Karaikudi– 630 004, Tamil Nadu, India.

- ✓ M.Phil-Industrial Chemistry, Alagappa University, Karaikudi, 2008.
- ✓ M.Sc-Chemistry, Alagappa University, Karaikudi, 2007.
- ✓ B.Sc, Chemistry, Madurai Kamaraj University, 2003.

Professional Experience

- ✓ Assistant Professor (04.12.2015– till date) ~4 years
  Dept of Bioinformatics, Alagappa University, Karaikudi -630003, Tamilnadu, India
- ✓ Research Associate-HRDG-CSIR, New Delhi, CECRI-Karaikudi (01.10.2015 to 03.12.2015).

Honours and Awards

1. JRF-Project Assistant -CSIR, CECRI, Karaikudi (06.04.2009 to 05.10.2009)
2. Best research paper Award presented in seminar on Application of Nanotechnology, in current agricultural practices, Dr.Zahir Husain College, Ilayankudi (2011).
3. Junior Research Fellow- (UGC-BSR, New Delhi)-Alagappa University, Karaikudi (08.02.2011 to 08.02.2013)
4. Senior Research Fellow- (UGC-BSR, New Delhi)-Alagappa University, Karaikudi, (09.02.2013 to 26.09.2014)

Recent Publications

1. Palanisamy, R. Anjali, M. Vinosha, M. Reka S. Selvakumar, **P. Boomi**, K. Anand, N.M. Prabhu, S. N. Selliah, Sang GuanYou,Synthesis of Oldenlandia umbellata stabilized silver nanoparticles and their antioxidant effect, antibacterial activity, and bio-compatibility using human lung fibroblast cell line WI-38, Process Biochemistry, Accepted, (I.F.2.883).
2. C. Zhao, J. Jiao, W. Zhou, Y. Zhang, H. Liu, X. Yang, **P. Boomi**, Y. Cai, July, (2019), A Novel Design and Fabrication of Ascorbic Acid Sensitive Biosensor Based on Combination of HAP/rGO/AuNPs Composite and Ascorbate Oxidase, Journal of Cluster Science, Accepted, doi.org/10.1007/s10876-019-01647-z. (2.125)
3. K. Natchimuthu, **P. Boomi**, S. Ramasamy, D. Karthik, R. Balachandar, May, (2019), Optimization of culture medium for improved production of antimicrobial compounds by Amycolatopsis sp. -AS9 isolated from vermicasts, Biocatalysis and Agricultural Biotechnology, 20, 101186.
4. R. Balachandar, P. Gurumoorthy, N. Karmegam, H. Barabadi, R. Subbaiya, K. Anand, **P. Boomi**, M. Saravanan, May, (2019) Plant-Mediated Synthesis, Characterization and Bactericidal Potential of Emerging Silver Nanoparticles Using Stem Extract of Phyllanthus pinnatus: A Recent Advance

in Phytonanotechnology, Accepted, Journal of Cluster Science, doi.org/10.1007/s10876-019-01591-y (I.F. 2.125).

5. **P. Boomi,** G. Poorani, S.Palanisamy, S. Selvam, G. Ramanathan, S. Ravikumar, H. Barabadi, H. Gurumallesh Prabu, J.Jeyakanthan, M. Saravanan, March, (2019), Evaluation of Antibacterial and Anticancer Potential of Polyaniline-Bimetal Nanocomposites Synthesized from Chemical Reduction Method, Journal of Cluster Science, 30, 715–726 (I.F. 2.125).
6. M. Anandan, G. Poorani, **P. Boomi**, K. Varunkumar, K. Anand, A. Anil Chuturgoon, M. Saravanan, H. Gurumallesh Prabu, February, (2019), Green synthesis of anisotropic silver nanoparticles from the aqueous leaf extract of Dodonaea viscosa with their Antibacterial and Anticancer activities, Process Biochemistry, 80, 80–88, (I.F.2.883).
7. **P. Boomi**, R.M. Ganesan, G. Poorani, H.G. Prabu, S. Ravikumar, J. Jeyakanthan, January, (2019), Biological synergy of greener gold nanoparticles by using Coleus aromaticus leaf extract, Materials Science & Engineering C, 99, 202–210 (I.F. 4.959).
8. R, Anjali, S. Palanisamy, M. Vinosha, M. Thenmozhi, P. Rajasekar, T. Marudhupandi, P. Kumar, **P. Boomi**, N.M. Prabhu, August, (2018), Phyto-mediated synthesis of silver nanoparticles using fucoidan isolated from Spatoglossum asperum and assessment of antibacterial activities, J. Photochem. Photobiol, 185, 117–125 (I.F-4.067).
9. **P. Boomi**, J. Anandha Raj, S.P. Palaniappan, G. Poorani, S. Selvam, H.G. Prabu, P. Manisankar, J. Jeyakanthan, V.K. Langeswaran, January, (2018), Improved conductivity and antibacterial activity of poly(2-aminothiophenol)-silver nanocomposite against human pathogens, J. Photochem. Photobiol, 178, 323–329. (I.F-4.067).

Cumulative Impact Factor: 138.91; Total Citations: 502; h-Index: 12; i10-index: 18

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Educational Qualification

Ph. D in (Molecular Biology – Pharmacology & Environmental Toxicology) from Department of Pharmacology & ET,Post Graduate Institute of Basic Medical Sciences, University of Madras, Taramani Campus, Chennai, Tamil Nadu, India (2007-2010).
Title: Chemotherapeutic efficacy of limonin on human hepatoma cell line (HepG2) and against aflatoxin B_1 induced experimental hepatocellular carcinoma"
Mentor: Dr. M. P. Balasubramanian, Professor, University of Madras.

M.Sc (Molecular Biology) from Department of Genetics, Institute of Basic Medical Science, University of Madras,Taramani Campus, Chennai, Tamil Nadu, India (2003-2005)

B.Sc (Microbiology) from Department of Microbiology,KandaswamyKandar's College,PeriyarUniversity, Tiruchirappalli, Tamil Nadu (1999-2002).

Professional Experience

Assistant Professor (01.02.2016 – till date) ~3 years
Dept of Bioinformatics, Alagappa University, Karaikudi -630003, Tamil Nadu, India
Assistant Professor (03.11.2014 - 30.11.2015) ~ 1 year
Department of Microbiology,
Imayam arts &science college for women, Thuraiyur.

Assistant Professor (01.08.2012 – 29.08.2014) ~2 years
Department of Biotechnology,
Sivagamiammal college of arts & science, Krishnagiri.

Assistant Professor (08.12.2010 – 30.06.2012) ~ 1.5 years
Department of Industrial Biotechnology,
Bharath University, Chennai.

Recent Publications

Langeswaran K, Santhosh Kumar S, Gavaskar S. Antioxidant, anti-microbial and anti-cancer effectiveness of marine macro alga Ulva fasciataDelile. Biomedical Research. 2019; 30 (4): 617-627.
Dharani N, Langeswaran K, Santhoshkumar S. Identification of novel inhibitor targeting Fyn kinase using molecular docking analysis. Journal of Bioinformation. 2019; 15(6): 419-424.
Langeswaran K, Jeyakanthan J, JegannathBabu R, Abir Biswas, Dhurgadevi KR. Identifying Dual Leucine Zipper Kinase (DLK) inhibitors using E-Pharamacophore screening and molecular docking. Journal of Receptors and Signal Transductions. 2019; 39(1): 1-7.
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Educational Qualification

- ✓ Ph. D in Soil Science in University of California, riverside, CA in 1998
- ✓ B. S. Agronomy in Environmental Soil Science in Birgham Young University, Provo UT, Cumlaude 1994.
- ✓

Professional Experience

- ✓ Visiting Scientist in Scotts Miracle Grow Corporation, Marysville Ohio (1/2017 to 5/2017)
- ✓ Director in Instittute for Comparative and Environmental Toxicology, Cornell Univeristy, Ithaca, NY (9/2005 to 12/2013)
- ✓ Associate Professor in Departmetn of Microbiology, Cornell Univeristy, Ithaca NY (07.2005 – Till date.
- ✓ Guest Professor in LABMET University of Ghent, Ghent Belgium (1/10 – 8/10)
- ✓ Interim Director in Center for the Environment, Cornell University, Ithaca NY (8/07 to 6/08).
- ✓ Assistant Professor in Departmetn of Microbiology, Cornell Univeristy, Ithaca NY (8/99 – 6/05)
- ✓ Alexander Hollaender Distinguished Postdoctoral Fellow in U.S. Department of Energy, Center for Environmental Biotechnology, University of Tennessee, Knoxville, TN (Advisor Dr. G.S. Sayler) (9/97) – 7/99)
- ✓ Chancellor's Distinguished Graduate Fellow in University of California Riverside, Riverside, CA. (9/94 – 9/97)

Recent Publications

- ✓ H Hu, H Zhou, S Zhou, Z Li, C Wei, Y Yu, **AG Hay**, Fomesafen impacts bacterial communities and enzyme activities in the rhizosphereEnvironmental Pollution 253, 302-311, 2019.
- ✓ N Cohen, H Zhou, **AG Hay**, A, Curli production enhances clay-E. coli aggregation and sedimentation RadianColloids and Surfaces B: Biointerfaces, 110361, 2019.
- ✓ AM Truhlar, TG Denes, KK Cantilina, SK Leung, MT Walter, **AG Hay**. Absence of genetic selection in a pathogenic Escherichia coli strain exposed to the manure-amended soil environment. PloS one 13 (12), e0208346, 2018.
- ✓ J Zhao, S Pacenka, J Wu, BK Richards, T Steenhuis, K Simpson, **AG Hay**. Detection of glyphosate residues in companion animal feedsEnvironmental pollution 243, 1113-11185, 2018.
- ✓ V Phandanouvong-Lozano, W Sun, JM Sanders, **AG Hay**. Biochar does not attenuate triclosan's impact on soil bacterial communitiesChemosphere 213, 215-225, 2018.
- ✓ H Zhou, W Gu, W Sun, **AG Hay**. A microbial community snapshot of windrows from a commercial composting facilitypplied microbiology and biotechnology 102 (18), 8069-8077, 2018.
- ✓ Y Yu, F Nie, **AG Hay**, H Lin, Y Ma, X Ju, D Gong, J Chen, R Gooneratne. Histopathological changes in zebrafish embryos exposed to DLPCBs extract from Zhanjiang coastal sedimentEnvironmental monitoring and assessment 189 (6), 2891, 2017.
- ✓ G Le Bihan, JF Sicard, P Garneau, A Bernalier-Donadille, AP Gobert,…..**AG Hay**. The NAG sensor NagC regulates LEE gene expression and contributes to gut colonization by Escherichia coli O157: H7...Frontiers in cellular and infection microbiology 7, 1348, 2017

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Educational Qualifications:

S.No	Degree	University	Year	Subjects
1	B.Sc	University of Madras, INDIA	1987	Physics
2	M.Sc	Bharathiyar University, INDIA	1989	Physics
3	M.Phil	University of Madras, INDIA	1990	Crystallography & Biophysics
4	Ph.D	University of Madras, INDIA	1997	Crystallography & Biophysics

Details of professional training and research experience, specifying period.

Institution	***Designation***	***Nature of work***	***Duration***
Centre of Advanced study in Crystallography and Biophysics, University of Madras, Chennai-600025	Research Scholar	Research and Teaching M.Sc (Practical classes).	1991- 1997
Centre for Biophysical Sciences and Engineering, University of Alabama at Birmingham, Birmingham, AL 35294, USA	Post Doctoral Fellow	Research	1998-2001
Centre for Biophysical Sciences and Engineering, University of Alabama at Birmingham, Birmingham, AL 35294, USA	Senior Research Associate	Research	2001-2005
Centre of Advanced study in Crystallography and Biophysics, University of Madras, Chennai -25.	Associate Professor	Research/ Guiding Ph.D students and Teaching M.Sc course	2005-2011
Centre of Advanced study in Crystallography and Biophysics, University of Madras, Chennai-600025	Professor	Research/ Guiding Ph.D students and Teaching M.Sc course	2011- till date

Total number of publications in peer reviewed journals: 62
Book chapters published: 2
No. of structures deposited in PDB: 50
US patent:01
US patent application number: 20040101919
Filed: September 15,2003
Title: Bioinformatic method for identifying surface-anchored proteins from gram-positive bacteria and proteins obtained thereby
Inventors: Hook, Magnus; *(Houston, TX)***;** Xu, Yi; *(Houston, TX)***;** Sillanpaa, Jouko V**.**; *(Houston, TX)* ; Sthanam, Narayana; *(Birmingham, AL)***; Ponnuraj, Karthe**; *(Birmingham, AL)* ; Patti, Joseph M.; *(Cumming, GA)***;** Hutchins, Jeff T.; *(Cumming, GA)***;** Hall, Andrea; *(Acworth, GA)***;** Bowden, Maria G.; *(Sugarland, TX)*

Recent honors/awards

1. **"National Bioscience award – 2010**" by Dept. of Biotechnology (DBT), Govt. of India
   (For significant contributions in the field of structural biology of bacterial adhesins)
2. Elected to the executive council of the Indian Biophysical Society (IBS) – (2011-2015)

3. Elected to the executive council of the International Union of Pure and Applied Biophysics (IUPAB), Biophysics council - India – 2016-2019
4. Elected to the executive council of the Indian Crystallographic Association (ICA) – (2016-2018)
5. Editorial Board Member – Biophysical Reviews – Springer Nature

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Educational Qualification

- ✓ M.Pharm (Pharmacy) from Dr. M.G.R Medical University, Chennai (1996-1998)
- ✓ MBA Business Development from M.K. University, Madurai (1996-1999)
- ✓ Advance Diploma in Bioinformaticsfrom M.K. University, Madurai (1999-2000)
- ✓ B.Pharm (Pharmacy) from Dr. M.G.R Medical University, Chennai (1988-1992)

Professional Experience

- ✓ Vice-President, Schrödinger, Bangalore (2013-Till date)
- ✓ Executive Director, Schrödinger, Bangalore (2011-2013)
- ✓ Senior Director, Schrödinger, Bangalore (2009-2011)
- ✓ Director, Schrödinger, Bangalore (2008-2009)
- ✓ Application Scientist, Schrödinger, Bangalore (2006-2008)
- ✓ Scientist, De-Shaw & Co, Hyderabad (2003-2006)
- ✓ Scientist, TATA Elxi, Bangalore (2001-2003)
- ✓ Scientist, Biocon, Bangalore (2000-2001)
- ✓ Asst. Professor in PSG Institute of Medical Sciences and Research, Coimbatore (1998-1999)

Honours and Awards

- ✓ **Life Time Achievement Award** byMilad-e-Sherif, Kerala.
- ✓ **Life Time Achievement Award** by Antiviral Research Society**.**

Recent Publications

- NIL -