M. Sc Bioinformatics

[Choice based Credit System (CBCS)]

Regulations, Description and Syllabus

[For those who join the Course in July 2019 and after]

DEPARTMENT OF BIOINFORMATICS

(DST-FIST and PURSE Sponsored Department)

ALAGAPPA UNIVERSITY

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC)

KARAIKUDI-630 004, TAMIL NADU, INDIA

ALAGAPPA UNIVERSITY

(A State University Accredited with "A+" grade by NAAC (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 50-55	6.0 5.5	5.51-6.00 5.00-5.50	B C	Second Class
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 in **USD $ 250**

Special and other fees shall be as prescribed by the University

10. 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.

11. 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.

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**

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

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

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 Immunotechnology

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

ALAGAPPA UNIVERSITY, KARAIKUDI

DEPARTMENT: BIOINFORMATICS

SEMESTER-I

Course Depiction

Program: M.Sc.,	Semester : I (2019-20)
Course Title**: Introduction to Bioinformatics** (502101)	Class Time: 10-1 and 4-5: Tuesday
Name of Course Teacher	Dr. J. Joseph Sahayarayan & Dr. Sanjeev Kumar Singh
Mobile: +91 - 9047564087 & +91 - 9894429800	Email: bioinformaticsjoseph2015@gmail.com & skysanjeev@gmail.com

Code: 502101 Introduction to Bioinformatics

Course Brief:

The course depicts the fundamental concepts and methods in Bioinformatics, a field at the junction of Biology and Computing. Data intensive, large-scale biological problems are addressed from a computational point of view. The most common problems are modeling biological processes at the molecular level and making inferences from collected data. The course covers the principles and methods used to search and compare DNA, RNA and proteins, cast as biological "sequences". The course explains why they can give us answers to fundamental biological questions important to fields such as Cell Biology, Biochemistry and Medical science. The important public data banks that provide details of biological systems and components will be discussed. It reviews a wide range of topics including open resources in bioinformatics, computational sequence analysis, sequence homology searching, gene finding and genome annotation, protein structure analysis and prediction, genomics, proteomics, phylogenetic analysis, biological databases, cheminformatics and medical informatics. Protein structures are three-dimensional data and the associated problems are structure prediction (secondary and tertiary), analysis of protein structures for clues regarding function, and structural alignment. It serves a gateway course for all science students.

Text Books:

1. Lesk, A.M. (2014) “Introduction to Bioinformatics”; Oxford University Press, UK, Fourth edition.
2. Gretchen Kenney, (2016) "Bioinformatics: Principles and Analysis"; Syrawood Publishing House USA.

Reference Books:

1. Higgins D. and Taylor W. (2000). Bioinformatics. Cary: Oxford University Press, 1st edition, ISBN 13: 9780199637904.
2. Scott Markel (2003) "Sequence Analysis in a Nutshell – A Guide to Common Tools & Databases"; O'Reilly; 1 edition, ISBN-13: 978-0596004941.
3. Bergeron B. (2003). Bioinformatics Computing - The Complete Practical Guide to Bioinformatics for Life Scientists, by Prentics- Hall, Inc., New Jersey 07458, USA, 1st edition, ISBN :81-203-2258-4.
4. Bourne P. E. Weissig H. (2003). Structural Bioinformatics, published by John Wiley & Sons, Inc., Hoboken, New Jersey, 1st edition, ISBN: 0-471-20200-2.
5. David Mount, (2004), "Bioinformatics: Sequence and Genome Analysis"; Cold Spring harbor laboratory Press, US Revised Edition.
6. Ole Lund, Nielsen, M., Lundegaard, C. Kesmir, C. and Brnak, S. (2005) "Immunological Bioinformatics"; The MIT press.
7. Xiong J. (2006). Essential Bioinformatics. Cambridge: Cambridge University Press., 1st edition, ISBN-13 978-0-511-16815-4.
8. Jean-Michel, Cand Notredame, C. (2006) "Bioinformatics for Dummies"; John Wiley& Sons, Second Edition.
9. Kindreas D Batevanis, (2006) "Bioinformatics: A Practical Guide to the Analysis of Gene and Protein"; Wiley Inter Science, Singapore, 3rd Edition.
10. Andrew R. Leach & Valerie J. Gillet, (2007) "An Introduction to Chemoinformatics"; Springer, Revised Edition.
11. David Edward, (2007) "Plant Bioinformatics": Methods and Protocol, Humana Press.
12. Rastogi S. C. Mendiratta N. and Rastogi P. (2008). Bioinformatics Methods and Applications - Genomics, Proteomics and Drug Discovery, published by PHI Learning Private Limited, New Delhi, Third edition, ISBN: 978-81-203-3595-0.
13. Posada D. (2009). Bioinformatics for DNA sequence analysis. New York: Humana Press, 1st edition, ISBN-13: 978-1588299109
14. 6. Gopal S. Jones R. Tymann P. and Haake A. (2010). Bioinformatics. Tata McGraw-Hill, 1st edition, ISBN-10: 0073133647
15. Yang, Z. (2010). Machine learning approaches to bioinformatics. Singapore: World Scientific, 1st edition, ISBN-13: 978-9814287302

16. Baxevanis, A.D. and Francis Ouellellette, B.F. (2011) "Bioinformatics –a practical guide to the analysis of Genes and Proteins"; John Wiley & Sons, UK, Third Edition.
17. Hossein G. Gilani, Katia G. Samper, Reza Khodaparast Haghi, (2012) "Chemoinformatics: Advanced Control and Computational Techniques"; Apple Academic Press, First edition.
18. Pérez-Sánchez, H. (2012). Bioinformatics, Rijeka, Croatia: InTech, 1st edition, ISBN: 980-953-307-202-4
19. Caroline St Clair, Jonathan E. Visick, (2013) "Exploring Bioinformatics"; Jones and Bartlett Publishers, Inc; 2nd Edition, ISBN-13: 978-1284034240.
20. Arthur Lesk, (2013) "Introduction to Bioinformatics"; OUP Oxford; 4 Edition, ISBN-13: 978-0199651566.
21. Kayvan Najarian, Siamak Najarian, Shahriar Gharibzadeh, (2017) "Systems Biology and Bioinformatics: A Computational Approach"; CRC Press; 1 Edition, ISBN-13: 978-1138118034.
22. Keith J. (2017). Bioinformatics. Totowa, NJ: Humana Press, a part of Springer Science Business Media, LLC, 2nd edition, ISBN 978-1-60327-429-6

Course Objectives: To make the students:

i. To make students understand the essential features of the interdisciplinary field of science for better understanding biological data.

ii. To provide the student with a strong foundation for performing further research in bioinformatics.

iii. To create students opportunity to interact with algorithms, tools and data in current scenario.

iv. To make the students look at a biological problem from a computational point of view.

v. To find out the methods for analyzing the expression, structure and function of DNA, RNA and proteins, and an understanding of the relationships between species.

Course Outcomes: The students shall be able to

i.	The student should be able to understand basic research methods in bioinformatics.
ii.	The student will choose biological data, submission and retrieval it from databases and design databases to store the information.
iii.	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.
iv. The students will be able to experiment pair wise and multiple sequence alignment and will analyze the secondary and tertiary structures of protein sequences.
v. The student should understand the data structure (databases) used in bioinformatics and interpret the information (especially: find genes; determine their functions), understand and be aware of current research and problems relating to this area.
vi. The student should be able to carry out gene and protein expression patterns and modeling cellular interactions and processes.

Teaching Methods: The mode of teaching is based on the following learning activities:

- Lectures covering the theoretical part will be delivered using PowerPoint presentations.
- A set of laboratory exercises to analyze biological problems using softwares and tools to develop student's interests in scientific discovery.
- Case studies in informatics-based research.

Grading System

< 50 Marks in all	50 <Obtained Marks < 59	60 < Obtained Marks < 75	Obtained Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: The students are expected to attend the classes regularly, since regular attendance is essential to gain academic achievement. As per the University norms, the students having a minimum scale of 70-75% attendance are only qualified to write their end-semester examinations.

Punctuality: Punctuality is the most important quality for the student to be followed and maintained to achieve success. Students who arrive late by 10 mins to the class without any vital reason will be marked absent in the attendance register. On the other hand, valid

excuse including personal or medical emergency is acceptable, with prior consent by the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking practice and much more that will provide a wholesome enriched classroom experience. When students participate, they learn from one another and gain their knowledge better.

Submission of Assignment: Assignments are given to students in order to apply the concepts for deeper understanding of the subject. Therefore, each student will be allocated two assignments for the course, covering the entire topic. Students will be given deadline to submit the assignment by the course instructor and good preparation of assignment will help the students for their final exams.

Presentation of Seminar: Apart from the assignments, students are supposed to give an oral presentation during the class seminar hours in their assigned topic. The concerned instructor will encourage the participants to ask valid questions during seminar presentation in order to put up their confidence levels and communication skills. In addition, students will be able to gain information and can be updated in their course.

Preparedness: At the end of every class, the concerned instructor conveys the students about the details that will be handled in the next class to increase the student's awareness related to the topics.

Academic Dishonesty: Academic dishonesty is a completely unacceptable mode of conduct and every student should be aware of this important aspect. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Depending upon the requirement of student's possibility, the course syllabus will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairperson.

Important dates: Scheduled dates for the various activities related to the course

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test I	

Course Outline: Core: Introduction to Bioinformatics- (5 Credits)

- An overview of bioinformatics-concepts and basic terminology used in bioinformatics-scope of bioinformatics in biological system- basic introduction to bioinformatics computing and includes background information on computers in general, the fundamentals of the UNIX/Linux operating system-various open resources essential for bioinformatics.
- Bioinformatics Sequence analysis **-** biological basics needed in bioinformatics, Sequence alignment-Global and Local- Pairwise Alignment, Multiple Alignment-ClustalW.
- Phylogenetics-Phylip package-Various tools used for sequence analysis-BLAST-types-Algorithms used in sequence alignments-Hidden Markov Model for gene detection- Needleman–Wunsch algorithm- Smith–Waterman algorithm-Dynamic Programming-Dot matrix analysis-Parsimony.
- Databases-Concepts and introduction of different data types-Various protein databases-Protein Data Bank-MMDB-Swiss-Prot, Protein information resources-primary and secondary nucleotide databases-importance of SCOP, PROSITE,CATH.
- Carbohydrate databases-Drug-drug interaction studies-synergism and antagonism-Entrez as information retrieval system.
- Cheminformatics-tools- chemical database-PUBCHEM, SMILES, ACD, Chembank; Structural visualization tool.
- Pharmacy informatics- medication-related data and knowledge within the continuum of healthcare systems - including its acquisition, storage, analysis, use and dissemination - in the delivery of optimal medication-related patient care and health outcomes-Medical coding-Application of pharmacoinformatics-ethical issues in medical informatics.

More books for Reading and Referencing

Introduction To Bioinformatics- **Attwood** Publisher: Pearson Education Singapore Pte Ltd, 2007. (**ISBN: 978-81-775-8641-1**)
Bioinformatics Basics: Applications in Biological Science and Medicine- **Hooman Rashidi, Lukas K. Buehler** Publisher: CRC Press/Taylor & Francis Group, 2005. (**ISBN: 978-08-493-2375-1**)
Bioinformatics in the Post-Genomic Era: Genome, Transcriptome, Proteome, and Information-Based Medicine- **Jeffrey Augen** Publisher: Addison-Wesley, 2004. **(ISBN: 978-03-211-7386-7)**

Introduction to Bioinformatics: A Theoretical and Practical Approach- **Stephen A. Krawetz, David D. Womble** Publisher: Humana Press, 2003. **(ISBN: 978-15-882-9241-4)**
Fundamental Concepts of Bioinformatics**- Dan E. Krane, Michael L. Raymer** Publisher: Benjamin/Cummings, 2002. **(ISBN: 978-08-053-4633-6)**
Bioinformatics: Sequence, Structure and DatabanksA Practical Approach- **Des Higgins, Willie Taylor** Publisher: Oxford University Press, 2000. **(ISBN: 978-01-996-3790-4)**
Chemoinformatics: A Textbook- **Johann Gasteiger, Thomas Engel** Publisher: Wiley publication, 2004. **(ISBN: 978-35-273-0681-7)**
Pharmacy Informatics- **Philip O. Anderson, Susan M. McGuinness, Philip E. Bourne** Publisher: CRC press, Taylor and Francis group, 2010. **(ISBN: 978-14-200-7175-7)**

Introduction to Bioinformatics (5 Credits)

Syllabus	Schedule
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.	**10 days**
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.	**10 days**
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	**14 days**
Unit-IV **Cheminformatics:** Introduction; Cheminformatics tools; Chemical structure representation (SMILES and SMARTS); Chemical Databases: CSD, ACD, WDI,	**10 days**

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.	**14 days**
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance	**8 days**

Assignment & Seminar - Introduction to Bioinformatics (5 Credits)

1. Basic commands of Windows, Unix and Linux operating systems
2. To learn Sequence Analysis using a known gene/protein
3. Database analysis using publicly available datasets.
4. To analyze the structure using Cheminformatics tools.
5. To practice an example of Pharmacy Informatics.
6. Explain the concept of open resources in bioinformatics.
7. Write a short note on global and local alignment.
8. Describe the salient features and importance of NCBI.
9. Give a detailed note on nucleotide sequence databases.
10. Explain the applications of Markov chains and Hidden Markov Model to gene analysis.

Code: 502102 Biochemistry and Molecular Cell Biology

Program: M.Sc.,	Semester : I (2019-20)
Course Title: **Biochemistry and Molecular Cell Biology (502102)**	Class Time: Monday : 10-12 Tuesday : 2-3 Wednesday : 2-4 Thursday : 11-1 Friday : 2-4
Name of Course Teacher	Dr. J. Joseph Sahayarayan
Mobile: +91 - 9047564087	Email : bioinformaticsjoseph2015@gmail.com

Name of Course Teacher	Dr. VK. Langeswaran
Mobile: +91 - 9884495511	Email : dr.langeswaran@gmail.com
Name of Course Teacher	Dr. P. Boomi
Mobile: +91 - 9486031423	Email : pboomi1983@gmail.com

Course Brief:

Biochemistry and Molecular Cell Biology have unique properties that determine how they contribute to the structure and function of cells and participate in the processes necessary to maintain life. Students will come to an understanding of the central dogma of molecular biology: DNA makes RNA, and RNA makes protein. They will learn about how we classify the different amino acids and their bonding form the building blocks of complex proteins. The study of structures and functions of biomolecules that include carbohydrates, lipids, proteins and nucleic acids, which controls and processes the metabolism at cellular levels promoted by specific catalysts, flow of genetic information and gene regulation, DNA technology, role of biomolecules in normal physiological systems with some medical applications. The course includes the molecular and cellular basic functions of life with specific foci on mechanisms that facilitate development of multicellular organisms (growth and heredity, interactions between cells, cell motility and transport and cell specialization). The part is built around human development from germ cells to an embryo and gives an introduction to the most important functions of the cell and its structures, embryology and the molecular mechanism of the developmental biology. The part includes elementary gene regulation with an emphasis on eukaryotes and molecular biological methods to study gene regulation. Usage of bioinformatics tools to study complex regulatory relationships and clinical genetics with an emphasis on human hereditary diseases. The part gives an overview of the latest methods that are used in medical research. The course is completed with an integrating project where the contents from the parts Biochemistry, Cell biology and Molecular biology and genetics are examined summationally.

Reference/Text Books:

Text books:

1. Nelson, DL., Cox, MM. (2004). Lehninger's Principle of Biochemistry. Freeman, 4th ed.

2. Murray, RK., Granner, DK., Mayes, PA., Rodwell, VW., (2006). Harper's Biochemistry. McGraw Hill, 27th ed.

3. De Robertis EDD., De Robertis EMF., Cell & Molecular Biology. waverly publication.

4. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K., Watson, JD. (1991). Molecular Biology of the cell. Garland publishers, Oxford 3rd edn.

Reference Books:

1. Voet, D., Voet, J., (2010). Biochemistry Part III, " Biomolecules - Mechanisms of Enzyme Action and Metabolism" John Wiley & Sons, INC, 4th Edition.

2. Berg Jermy, M., Tymoczko John, L., Gatto Gregory, J., Stryer Lubert, JR. (2015). "Biochemisty" Macmillan Learning, Bedford Freeman & Worth Publishing Group, 8th Edition.

3. A.L. Lehninger. (2017). "Principles of Biochemistry"; W.H. Freeman and Company, 7th edition.

4. Russel, PJ. (2010) "iGenetics – A Molecular Approach"; Pearson Educational Limited, 3rd Edition.

5. Alberts, B. (2014) "The Molecular Biology of The Cell"; Garland Science Publisher, 6th Edition.

6. Lewin, B. (2017) "Genes XII"; Jones and Bartlett Learning.

7. Alberts, B. Bray, D, lewis, J, Raff, M. Roberts, K, Hopkin, K, Johnson, A. (2014). "Essential Cell Biology"; Garland Science Publisher, 4th Edition.

8. Berg Jermy, M, Tymoczko John, L, Gatto Gregory, J , Stryer Lubert, JR. (2015) "Biochemisty"; Macmillan Learning, Bedford Freeman & Worth Publishing Group, 8th Edition.

9. Watson, J.D, Levine, M. Losick, R. Gann, A, Bell, S P. (2013). "Molecular Biology of the Gene; Pearson Educational Limited,m", 7th Edition.

10. Lodish, H. (2016) "Molecular Cell Biology"; W.H Freeman Publisher, 8th Edition.

11.Cooper, G.M. Hausman, R.E. (2015)"The Cell: A Molecular Approach; Oxford University Press", 7th Edition.

12. Karp, G, Marshell ,W, Twasa, J. (2015) " Cell and Molecular Biology –Concepts and Experiments"; John Wiley & Sons, New York, 8th Edition.

13. De Roberties, E.D.P. De Roberties, E.M.F. (2010) "Cell and Molecular Biology", Lippincott Williams & Wilkins, 8th Edition.

Course Objectives: To make the students:

Students should be able to recognize all of the common organic functional groups important in biomolecules and understand how the group chemical properties relate to the biomolecular function. Students should be able to be familiar with structure and functions of the cell and cell organelles.

i. Identify and define different types of biomolecules and the important structural features of biomolecules.

ii. Classify carbohydrates, proteins, lipids and vitamins on the basis of their structure & functions.

iii. Give the composition of proteins and nucleic acids and explain the difference between DNA and RNA.

iv. Explain the action of enzymes and their characteristic features and list the functions of biomolecules in biological systems.

v. List the four major complex biomolecules found in living cells, three of which are found on food labels and the basis for grouping of biomolecules into those four groups.

vi. Provide basic genetic terminology at a general level and describe the organization and development of the genetic makeup on cellular, chromosomal and gene level and be able to explain the basic molecular genetics mechanisms in relation to the structure and function of the cells.

vii. Describe developmental biology molecular mechanisms for development and renewal of the cells in the main tissue types and the individual's development from formation of germ cells to embryo in relation to inheritance and environment.

viii. Describe basic mechanisms for cell growth, cell death, cell specialization, cell motility and interactions between cells and explain how these together facilitate the development of a multicellular organism.

ix. Explain different hereditary patterns for genetic diseases and be able to describe different ways at a general level to identify disease genes.

x. Explain various types of molecular biological methods that are used to study the regulation and function of biomolecules

Course Outcomes: The students shall be able to

i. Understand the principles, concepts and facts of the structure and their related functions of proteins.
ii. Recognize the structure and properties of simple carbohydrates, oligosaccharides and polysaccharides.
iii. To understand the structure properties and biological functions of lipids and biological membranes.
iv. Understanding of structure, properties and dificiency of vitamins and biological roles heterocyclic bases nucleotides and nucleic acids in living organism.

v. Describe in general terms how life began on earth and how early scientists important roles in furthering our understanding of cellular life.
vi. Able to list the organic and inorganic molecules that are necessary for life, further they can easily explain the structure and function of organelles in plant and animal cell.
vii. They will be proficient listing the similarities and difference animal and plant cell.
viii. They will be talented in explaining protein synthesis in eukaryotic cells and photosynthetic reaction in chloroplast of plant cells.
ix. This course completed graduates can able to explain genetic disorders in humans and genes responsible for it.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions
- Case-studies and Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive

late by 10mins after the attendance will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule:

CIA Test I	**CIA Test II**	**Assignment**	**Seminar**
As per Academic Calendar		After CIA Test-I	

Course Outline: Biochemistry and Molecular Cell Biology (5 Credits)

The physiological activities in all the living organisms' viz. movement, growth, respiration, digestion, excretion, respiration and response to stimuli are performed by the cells. The Cell is basic unit of structure and function in living system. The structural organization and functions of the cells are uniquely maintained by four major biomolecules namely carbohydrates, lipids, proteins and nucleic acids. The course encompasses the study of cell, cell organelles and deals with detail study of definition, classification, structure and cellular functions of its biomolecules carbohydrates, lipids, proteins and nucleic acids. The overall perspective will be the biomolecules their characteristic properties and organization in carrying out all the living functions which constitute the life.

Carbohydrates:

1. Identify their chemical elements and the difference between simple sugars and complex carbohydrates.

2. On the food labels, what do sugar or sugar alcohol and fiber refer to?

3. Compare and contrast the structure and function of the following carbohydrates and where they are found: glucose, glycogen, starch, cellulose and chitin.

Proteins:

1. Identify their chemical elements and functional groups.

2. Recognize the structure of an amino acid and the peptide bond that connects di-, tri and polypeptides.

3. Recognize the presence of 20 amino acids and that not all are essential amino acids.

4. Summarize the function of proteins and recognize the importance of the three dimensional shape of a protein on its function and the role of non-covalent bonds in maintaining the shape of a protein.

5. Explain protein denaturation and the effect of heat on protein structure and function.

Lipids:

1. Identify their chemical elements and learn their property of insolubility in water.

2. Identify the three groups of lipids.

3. Compare and contrast saturated, mono-unsaturated and poly-unsaturated fatty acids.

4. Explain the importance of poly-unsaturated fatty acids and why omega-3 and omega-6 fatty acids are considered essential.

5. List the sources of polyunsaturated fatty acids.

Nucleic Acids:

1. Identify their chemical elements and components of a nucleotide.

2. Describe the function of DNA.

3. Compare and contrast the 2 types of nucleic acids: DNA and RNA.

Enzymes:

1. Interpret steady-state and pre-steady state kinetic parameters of enzymatic reactions.

2. Bring together structural and kinetic information relevant to a specific reaction to propose a mechanistic model of enzyme catalysis.

3. Describe the characteristics of biological membranes and outline broad themes surrounding membrane channels and pumps.

More books for Reading and Referencing:

Biomolecules: (Introduction, Structure & Function) Carbohydrates by Suman Khowala, Deepak Verma, Samudra P. Banik (2008)
Biomedical Chemistry: Current Trends and Developments by Nuno Vale - De Gruyter Open Ltd , 2016 (ISBN: 13: 9783110468748)
RNA Interference by Ibrokhim Y. Abdurakhmonov (ed.) – InTech, 2016 (ISBN: 978-953-51-2272-2)

Biochemistry and Molecular Cell Biology (5 Credits)

Syllabus	Schedule
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.	**16 days**

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.	**14 days**
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.	**16 days**
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.	**9 days**
Unit-V **Gene Transfer methods and Population studies:** Genetic variations and	**14 days**

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.	
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance.	**5 days**

Assignment & Seminar – Biochemistry and Molecular Cell Biology (502102)

1. Composition of living matter.
2. Biomembrane organization and function.
3. Structure, diversity and function of nucleic acids.
4. Lipoprotein structure, properties and function.
5. Structure and properties of storage and membrane lipids.
6. General principles of enzyme catalysis
7. Regulatory steps in metabolic regulation.
8. Glycolytic pathway.
9. Kreb's cycle.
10. Basic principles of Bioenergetics

Code: 502103 Mathematics and Statistics for Biologists

Program: M.Sc.,	Semester: I (2019-20)
Course Title and Code: **Mathematics and Statistics for Biologists** (502103)	Class Time: 10 - 12: Wednesday and 10 -12: Friday
Name of the Course Teacher	Prof. J. Jeyakanthan
Mobile: +91 - 97898 09245	Email: jjkanthan@gmail.com
Name of the Course Teacher	Dr. M. Karthikeyan
Mobile: +91 - 9486981874	Email: mkbioinformatics@gmail.com

Course Brief:

Advances in mathematical methods and techniques in Bioinformatics have been growing rapidly. Mathematics has a vital role in describing the complexities of biological processes and structures. Mathematical analyses in the depiction of molecular structures

of Biological systems have essential meaning for Bioinformatics, Biomathematics and Biotechnology. Mathematics is used to elucidate trends, patterns, connections and relationships in a quantitative manner that can lead to important discoveries in biology. This syllabus is committed to bring a closer connection and better integration between mathematical methods and biological codes, sequences, structures, networks and systems biology. It is intended for graduate students and researchers who want an overview of the field and information about the possibilities and challenges presented at the interface between mathematics and bioinformatics. At the end of the course, the student will gain valuable knowledge about mathematical methods and tools, phenomenological results and interdisciplinary connections in the fields of Molecular Genetics, Bioinformatics, and Informatics. Biostatistics represents an introduction and provides a series of methodologies to analyze and handle different data and types. Specific topics include tools for describing central tendency and variability in data; methods for performing inference on population means and proportions via sampling the data; statistical hypothesis testing and its application to group comparisons; issues of power and sample size in study designs; and random sample and other study types. While there are some formulae and computational elements to the course, the emphasis is on interpretation and concepts. R programming represents as a promising tool for the statistic application in biology. It helps to analyze the basic statistics such as correlation, probability distributions, co-variance, T-test and ANOVA using R-programming.

Reference/Text Books:

Text Books:

1. Segal, L. (1980) "Mathematical Models in Molecular and Cellular Biology"; Cambridge: Cambridge University Press.
2. Isaev, Berlin, A. (2004) "Introduction to mathematical methods in bioinformatics"; Springer.
3. Zar, J.H. (1984) "Bio Statistical Methods"; Prentice Hall International Edition, USA
4. Gurumani,N., (2015)."An Introduction to Biostatistics", MJP Publisher, 2nd Edition.
5. Norman M. (2001) "The Art of R Programming – A Tour of Statistical Software Design", Cengage Learning.
6. Lander, P. (2017) "R for Everyone: Advanced Analytics and Graphics", 2nd Edition, Pearson.

Reference Books:

1. Raman, K.V. and Pal Sourav, P. (2005) "Mathematics in chemistry";Vikas publishing house Pvt. ltd., New Delhi.
2. Stephenson, F.H. (2003) "Calculations in molecular biology and biotechnology: a guide to mathematics in the laboratory"; Amsterdam, Academic Press.
3. Stephenson, G. and Radmore, P. M. (1990) "Advanced mathematical methods for engineering & science students".
4. Viergever, M.A. and Todd- Pokropek, Andrew (1988) "Mathematics and computer science in medical imaging".
5. Arfken, G. (1970) "Mathematical Methods for Physicists"; Academic Press, NY.
6. Roman P., Pergamon.(1975) "Some Modern Mathematics for Physicists and Other Outsiders"; New York, Vol. 2, p. 660.
7. Balaguruswamy. "Numerical Methods";Tata Megra Hill.
8. Warren, J., Gregory, E. and Grant, R. (2004) "Statistical methods in Bioinformatics"; First edition, Springer-Verlag, Berlin.
9. Milton, J.S. (1992) "Statistical methods in the Biological and Health Sciences"; Second Edition, McGraw Hill Publishers.
10. Rosner, B. (2005) "Fundamentals of Biostatistics"; Duxbury Press.

Course Objectives: To make the students:

i. Apply knowledge in modern industry, teaching, or secure acceptance in high-quality graduate programs of Bioinformatics.

ii. For better integration of the concepts at the intercepts of mathematical methods and biological codes, sequences, structures, networks, and systems biology.

iii. Understand and apply statistical techniques that are essential to process and interpret biological data.

iv. Introduce basic techniques and programming skills in bio-statistical approach and thereby presents a suitable opportunity for the students to represent their data in various interpretations.

Course Outcomes: The students shall be able to

i. Formulate as well as analyze mathematical and statistical problems, precisely define the key terms, and draw clear and reasonable conclusions.
ii. Use mathematical and statistical techniques to solve well-defined problems and present their mathematical work.

iii. Read, understand and construct correct mathematical and statistical proofs and use the library and electronic data-bases to employ information on mathematical problems.
iv. Explain the importance of mathematics and its techniques to solve real life problems and provide an alternative paradigm for the limitations of such techniques and validate the results accordingly.
v. Propose new mathematical and statistical questions and suggest possible software packages and/or computer programming to find solutions to these questions.
vi. Continue to acquire mathematical, statistical knowledge and skills appropriate for professional activities and demonstrate highest standards of ethical issues in mathematics.
vii. 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.
viii. Assessing the impact of chance and variability on the interpretation of research findings and subsequent recommendations for public health practice and policy.
ix. Biostatistics can be applied in major areas of drug design and discovery for example to evaluate the different hypotheses using ANOVA, t-test, correlation, and regression using R-programming for the data generated during the exercise of computational technique.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Solving complex equations using real time solving approaches that are associated with biological problems such as probability and statistics.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions
- Case-studies and Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		End-Semester Exam: 75 Marks
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

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Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics

that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

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Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test I	

Course Outline: Core: Mathematics and Statistics for Biologists (5 Credits)

- On completion of this course students will be able to follow the mathematical demonstrations and proofs used in Mathematics and Biostatistics, and to understand the mathematics behind statistical methods introduced at PG level.
- The intention is to allow students to concentrate on statistical concepts in subsequent courses, with an understanding of the mathematics employed.
- Content includes: exponential functions; vector algebra; calculus; integrals and differentiation; series, limits, approximations and expansions; matrices and determinants and numerical methods.
- Set theory and Probability: Addition law of probability, Conditional probability, Central limit theorem and Bayes theorem.
- R-Programming for Biostatistics: Basic statistics in R, probability distribution, correlation, ANOVA and student's t-test.

More books for Reading and Referencing

Matrix Methods and Differential Equations - A Practical Introduction **Wynand S. Verwoerd**; 2012 **(ISBN: 978-87-403-0251-6)**
Essentials of Statistics: Exercises **David Brink**; 2010 **(ISBN: 978-87-7681-409-0)**
A First Course in Ordinary Differential Equations **Norbert Euler**; 2015 **(ISBN: 978-87-403-1045-0)**

An introduction to partial differential equations **R.S. Johnson**; 2012 **(ISBN: 978-87-7681-969-9)**
Statistical methods in the Biological and Health Sciences"; Third Edition, McGraw Hill Publishers. **Milton, J.S.** ; 1998 **(ISBN:978-00-7290-148-1)**

Mathematics and Statistics for Biologists (5 Credits)

Syllabus	Schedule
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.	**6 days**
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.	**6 days**
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.	**6 days**
Unit-IV	**6 days**

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.	**5 days**
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance.	**5 days**

Assignment & Seminar - Mathematics and Statistics for Biologists (502103)

1. Solving Problems based on the exercises in Vector Algebra, Matrices and Determinants, Integral calculus Differential Calculus and Trigonometry.
2. Computational exercises using SAS packages and R programming.
3. To find the angle between vectors using scalar and vector products.
4. Describe the equations using vector expressions.
5. Students't' test and De Morgan's' Law.
6. Measures of central tendency.
7. Explain the principle, purpose and method of sampling?
8. Write short note on analysis of variance (ANOVA).
9. Differentiate between Regression and Correlation with suitable examples.
10. Power analyzes for sample size determination

Code: 502104 Lab-I Database Management System and MYSQL

Program: M.Sc., Bioinformatics	Semester : I (2019-20)
Course Title and code: Lab-I Database Management System and MYSQL (502104)	Class Time: 2-5 : Monday 2-3 : Tuesday 12-1 : Friday
Name of Course Teacher	Dr. R. M. VIDHYAVATHI
Mobile: +91 - 9444835869	Email : vidhyamiss@gmail.com

Course Brief

The primary goal of this course is to learn principles and practices of database management and database design. Applications development using database programming techniques emphasizing database structures, modeling, and database access. It includes representing information with the relational database model, manipulating data with an interactive query language (SQL) and database programming, database development including internet applications, and database security, integrity and privacy issues.

MySQL is one of the most popular RDBMS used today and a solid understanding of SQL is critical if the students want to have a successful career in web development. In this class is intended for analysts, developers, designers, administrators, and managers new to the SQL programming language. Upon completion, students will understand SQL functions, join techniques, database objects and be able to write queries and stored procedures.

Reference(s) /Text Books:

Text Books:

1. Silberschatz, A., Korth, H.F. and Sudarshan, S. (2010) "Database system Concepts", McGraw Hill Publishers, Fourth Edition.
2. Vaswani Vikram, (2017) "MySQL(TM): The Complete Reference", Tata McGraw Hill Publications, First Edition

Reference Books:

1. Rob, Coronel, (2014) "Database Systems", Cengage Learning, Seventh Edition.
2. Ramez Elmasri, Shamkant B. Navathe, (2010), "Fundamentals of Database Systems", Pearson / Addision wesley, Sixth Edition.
3. Paul DuBois, (2003)"MySQL Cookbook ", Sams Publishing, Second Edition.
4. Raghu Ramakrishnan & Johannes Gehrke, (2003)," Database Management System", McGraw-Hill Education, Third edition.
5. Date, C.J. (2000) "An introduction to Database systems", Addison Wesley Publishers, Seventh Edition.
6. Luke Welling, Laura Thomson, (2003)," MySql Tutorial", Sams Publishing.
7. Marc Delisle, (2006),"Creating your MySQL Database", Packt Publishing Ltd.

Course Objectives: To make the students

i. To provide a sound introduction to the discipline of database management as a subject in its own right, rather than as a compendium of techniques and product-specific tools.
ii. To give a good formal foundation on the relational model of data.

iii. To present SQL and procedural interfaces to SQL comprehensively.
iv. To present the concepts and techniques relating to query processing by SQL engines.
v. To present the concepts and techniques relating to ODBC and its implementations.
vi. To introduce the concepts of transactions and transaction processing.
vii. To present the issues and techniques relating to concurrency and recovery in multi-user database environments.
viii. Use built-in MySQL functions.
ix. Export and import database data.
x. Configure MySQL server and client programs.
xi. Configure simple and complex replication topologies.

Course Outcomes

i. Understand the services provided by a Database Management System. Database Administrators, Database Application Developers, Database Specialists, and DBMS developers.
ii. Identify the methodology of conceptual modeling through Entity Relationship model.
iii. Develop an understanding of the differences between OODBMS, ORDBMS and RDBMS and the practical implications of each approach.
iv. ER-model to relational tables, populate relational database and formulate SQL queries on data.
v. Understand Programming PL/SQL including stored procedures, stored functions, cursors, packages.
vi. To understand Design and build a GUI application using a 4GL.
vii. To create applications using MYSQL Admin Commands.

Teaching methods

The teaching includes lectures, discussions, demonstrations, concept maps and models, self-study and question times and an integrating project work. The project work is in-depth studies in groups with an emphasis on own work and literature studies. The course is completed with a written final examination.

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, seminars, reviews and class participation. The grade allocation is as follows:

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Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance has been taken will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course

Outline: Database Management System and MYSQL (4 Credits)

On completion of this course students will be able to acquire knowledge about

- Database Fundamentals and three levels of Database architectures.
- Install, configure, and interact with a relational database management system and MySQL.
- Utilize a database modeling technique for a single entity class.
- Implement the principles and concepts of information integrity, security and confidentiality.
- Normalization Theory: Functional dependencies, 2NF, 3NF, BCNF, 4NF, 5NF.
- Transactions, Concurrency, And Recovery: Transaction basics; Concurrency basics; Recovery basics; Shading in Mongo.
- Apply ethical computing concepts and practices to database design and implementation.
- Demonstrate the functions of MySQL. Use SQL to update an existing and create a table in the database.
- Database maintenance: Backing Up and Restoring MySQL Databases.
- Crash Recovery, MySQL Options File and Configuring and Tuning the MySQL Server.
- DBMS Data Security, Recovery, and Support and Database Administration.

More books for Reading and Referencing

Fundamentals of Database Systems: Ramez Elmasri & Shamkant B. Navathen, Pearson Education, 2016 .ISBN: 013-3970779.
High Performance MySQL: Optimization, Backups, and Replication, Baron Schwartz, Peter Zaitsev, Vadim Tkachenko, O'Reilly Media, Inc,2012. ISBN: 1449332498, 9781449332495
Concepts of Database Management System: Naik , Pearson Education India, 2013. ISBN **-10:** 9332526281, ISBN **-13:** 978-9332526280
Database Driven Web Development with Perl & MySQL, By Thomas Valentine, 2016 ISBN: 1484205154, 9781484205150.

Database Management System and MYSQL (4 Credits)

Syllabus	Schedule
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.	**12 days**
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).	**12 days**
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 .	**12 days**
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.	**10 days**
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	**11 days**
CIA Tests, Seminars, Presentations, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar - Database Management System and MYSQL (502104)

1. Overview and types of DBMS, Features of DBMS, E-R Model.
2. Logical view of data, keys, 1NF, 2NF, 3NF, BCNF.
3. MySQL data types with suitable example.
4. Write the basic commands in Linux and basic MySQL Queries.

5. MySQL Four different methods to start MySQL in Linux, MySQL Stopping, MySQL and its uses.
6. Write the Procedure of Installing MySQL in Various Operating Systems.
7. Explain MySQL Logs, Error Log, Query Log, Slow Query Log, Binlog and its format, Relay Log.
8. Describe MySQL Admin Commands and Explain Deadlock.
9. MySQL Table maintenance, Information Schema and Performance Schema in MySQL.

SEMESTER-II

Code: 502201 Phylogeny and Phylogenomics

Program: M.Sc.,	Semester: II (2019-20)
Course Title and Code: **Phylogeny and Phylogenomics (502201)**	Class Time: 3-4 : Wednesday 10-1: Friday
Name of the Course Teacher	Dr. M. Karthikeyan
Mobile: +91 - 9486981874	Email: mkbioinformatics@gmail.com

Course Brief:

This course is for students/researchers dealing with the analysis of multiple molecular sequences at several levels: Populations, species, clades, communities. These biologists address questions relative to the evolutionary relationships among these sequences, as well as the evolutionary forces structuring biodiversity at different scales. The course provides exceptional knowledge in Phylogenetics through computational algorithms and software skills.

References/Text Books:

Text Books:

1. Page, R. D. M. and Holmes, E.C. (1998) "Molecular Evolution A Phylogenetic Approach"; Blackwell Scientific.
2. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York.
3. Baxevanis, A.D. and Francis Ouellellette, B.F., (2009). "Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins" 3rd Edition, Wiley India.

Reference Books:

1. Graur, D. and W-H Li. (2000) Fundamentals of Molecular Evolution" 2nd Edition, Sinauer Associates.
2. Patthy, L. (1999) "Protein Evolution"; Blackwell Scientific.
3. Pankhurst, R.J.(1991) "Practical taxonomic computing";
4. Michael M. Miyamoto, (2001) Phylogenetic Analysis Of DNA Sequences, Oxford Press, New York
5. Philippe Lemey, Marco Salemi and Anne-Mieke Vandamme (2009) "The Phylogenetic Handbook: A Practical Approach to Phylogenetic Analysis and Hypothesis Testing"; 2nd Edition, Cambridge University Press.

Course Objectives: To make the students:

i. To understand concepts of molecular evolution and the nature of data for deriving molecular phylogeny
ii. To learn and apply the statistical approaches and models for phylogenetic analysis and tree reconstruction
iii. To gain knowledge about the algorithms used for the sequence alignment and its applications
iv. The main objectives of the course are to teach the theoretical bases of phylogenetic analysis, and to give the ability to initiate a phylogenetic analysis starting from the files of molecular sequences until the interpretation of the results and the graphics.

Course Outcomes:

i. This course covers the basic methods of phylogenetic analysis and their application in fields such as systematics, comparative biology, and molecular evolution.
ii. The course will enable students to use computational approaches for phylogenetic analysis.

iii. Learn to explore and use packages available for molecular phylogeny.
iv. Lectures will emphasize the logical basis and computational details of various tree-building algorithms and associated methods of hypothesis testing, as well as novel applications of phylogenetic analysis in various fields of biology.
v. Computer-based labs will give students the opportunity to implement these methods using a variety of phylogenetic software.
vi. Software and algorithm knowledge will provide students to develop customized statistical tools.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions
- Case-studies and Review questions

Grading System

<50 Marks in all	50< Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		End-Semester Exam: 75 Marks
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars, for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance has been taken will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	II CIA Test	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Core: Phylogeny and Phylogenomics (4 Credits)

- Basic concepts in systematics, taxonomy and phylogeny.
- Species concept, kingdom to species, the five kingdoms, classical, phenetic and cladistic approaches.
- Definition and description of phylogenetic trees and various types of trees.
- Fundamental concepts of neutral evolution, molecular divergence and molecular clocks.
- Protein and nucleotide sequence analysis.
- Gene duplication and divergence. concepts and rate of change in gene frequency through natural selection, migration and random genetic drift;
- Phylogenetic analysis algorithms: Maximum Parsimony, UPGMA, maximum likelihood algorithm and Bootstrapping methods.
- Transformed Distance - Neighbors-Relation, Neighbor-Joining, jackknife method.
- Gene discovery using Fourier analysis
- Survey of software programs available for phylogenetic analysis.

More books for Reading and Referencing

Phylogenetic Analysis Of DNA Sequences, Oxford Press, New York by Michael M. Miyamoto, 1992 (**ISBN:0-19-506698**)
Practical taxonomic computing by Pankhurst, R.J, 1991 (**ISBN: 0521417600, 9780521417600**)

Phylogeny and Phylogenomics (4 Credits)

Syllabus	Schedule
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	**6 days**

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.	**5 days**
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	**5 days**
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).	**6 days**

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 dandrogram 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.	**5 days**
CIA Tests, Seminars, Presentations, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar: Phylogeny and Phylogenomics (502201)

1. Write the difference between rooted and un-rooted trees.
2. Describe the character and distance based approaches.
3. Explain the role of Clustal W for phylogenetic analysis.
4. Define PHYLIP and its application.
5. Expand (a) UPGMA (b) NJ (c) Clustal W and (d) MEGA.
6. Give short note on evolutionary trace analysis.
7. How do you generate multiple datasets from the original input using bootstrapping?
8. Explain the importance of multiple sequence alignment for tree construction.
9. Discuss on Jackknife test.
10. Softwares for phylogenetic analysis

Code: 502202 Molecular Modeling and Drug Design

Program: M.Sc., Bioinformatics	Semester : II (2019-20)
Course Title: **Molecular Modeling and Drug Design (502202)**	Class Time: 10 - 1: Wednesday 2-3: Friday
Name of Course Teacher	Dr. Sanjeev Kumar Singh
Mobile: +91 - 9894429800	Email : skysanjeev@gmail.com

Course Brief:

The course depicts the basic theory of molecular modeling and drug design. It reviews a vast range of topics including the concept of molecular modeling; Quantum and Molecular Mechanics, *Ab initio* structure modeling and active site prediction, theories and to recognize drug like properties, computer molecular dynamics simulation and changes in conformations, pharmacophore, lead identification and *de novo* ligand design methods, molecular docking, QSAR, HTVS, Lipinski's rule, ADME properties, energy concepts, Bond structure and bending angles, finding new drug targets to treat diseases; drug discovery and development. It also discusses the recent advances and limitations of molecular modelling methods. This course serves as a basic introduction of molecular modeling to the students. As it covers a vast range of topics in molecular modeling, it could provide sound basic knowledge as well.

Reference/Text Books:

Text Books:

1. Leach, AR (2001) "Molecular Modeling – Principles and Applications"; Second Edition, Prentice Hall, USA
2. Schlick T, "Molecular Modeling and Simulation An Interdisciplinary Guide", Springer, Acc. No. 73052

Reference Books:

1. Doucet J. and Weber J. (1996). Computer-aided molecular design. London: Academic Press, 1st edition, ISBN 0-12-221285-1
2. Gundertofte K, (2000) "Molecular Modeling and Prediction of Bioactivity", Springer, ISBN-978-1-4613-6857-1.
3. Jiang T. Xu Y. Zhang M. (2002). Current topics in computational molecular biology. Cambridge, Mass.: MIT Press, 2nd edition, *ISBN*-10: 0262100924
4. Schneider G. and So S. (2003). Adaptive systems in drug design. CRC press, 1st edition, *ISBN* 9781587060595
5. Cramer CJ (2004) "Essentials of Computational Chemistry: Theories and Models", Wiley-Blackwell, ISBN- 978-0470091821.
6. Pirrung MC (2004) "Molecular Diversity and Combinatorial Chemistry: Principles and Applications", Elsevier, ISBN-0-08-044493-8.

7. Bajorath JB (2004) “Chemoinformatics-Concepts, Methods, and Tools for Drug Discovery”, Springer, ISBN 978-1-59259-802-1.
8. Nogrady T. and Weaver D. (2005). Medicinal chemistry. New York, N.Y.: Oxford University Press, 3rd edition, ISBN-13: 978-0195104561
9. Vogel H (2007) “Drug Discovery and Evaluation: Pharmacological Assays”, Springer, ISBN-978-3-540-70995-4.
10. Kukol A. (2008). Molecular modeling of proteins. Totowa, N.J.: Humana Press, 1st edition, ISBN 978-1-59745-177-2
11. Ramachandran KI (2008) “Computational Chemistry and Molecular Modeling: Principles and Applications”, Springer, ISBN- 978-3-540-77304-7.
12. Hinchliffe (2008) “Molecular Modelling for Beginners”; Second Edition, Wiley-Blackwell, ISBN- 978-0470513149.
13. Kukol (2010) “Molecular Modeling of Proteins”, Humana Press, ISBN- 978-1617378126.
14. Leach AR and Gillet VJ (2010) “An Introduction to Chemoinformatics”, Springer, ISBN – 10 8184892551.
15. Bajorath J (2010) “Chemoinformatics for Drug Discovery”, John Wiley & Sons, ISBN-978-1-118-13910-3.
16. Banting L. and Clark T. (2012). Drug design strategies. Cambridge, U.K.: Royal Society of Chemistry, 1st edition, ISBN: 978-1-84973-167-6
17. Gilani HG, Samper KG and Haghi RK (2012) “Chemoinformatics: Advanced Control and Computational Techniques”, CRC Press, ISBN-9781466559332.
18. Bladon P and Hammond RB (2012), “Molecular Modelling: Computational Chemistry Demystified” RSC publishing, ISBN: 978-1-84973-352-6.
19. Silverman RB and Holladay MW (2014) “The Organic Chemistry of Drug Design and Drug Action”, third edition, Elsevier, ISBN-978-0-12-38-2030-3.
20. Czechtizky W and Hamley P (2016) “Small Molecule Medicinal Chemistry: Strategies and Technologies”, John Wiley & Sons, ISBN-978-1-118-77160-0.
21. Dastmalchi S. Hamzeh-Mivehroud M. and Babak Sokouti (2018). Quantitative Structure - Activity Relationship: A Practical Approach. CRC Press. ISBN: 9780815362098
22. Sehgal, A. Mirza H. Tahir R. A. Mir A. (2018). Quick Guideline for Computational Drug Design. Bentham Science. ISBN: 978-1-68108-603-3

23. Hey-Hawkins E. Teixidor C. V. (2018). Boron-Based Compounds: Potential and Emerging Applications in Medicine. John Wiley & Sons. ISBN: 978-1-119-27558-9
24. Gervasio F. L. Spiwok V. Mannhold R. (2019). Biomolecular Simulations in Structure-Based Drug Discovery. John Wiley & Sons. ISBN: 978-3-527-342655
25. Andricopulo A. D. and Ferreira L. L. G. (2019). Chemoinformatics Approaches to Structure- and Ligand-Based Drug Design. Frontiers Media SA. ISBN: 978-2-88945-744-1

Course Objectives: To make the students:

i. To let students to understand the use of informatics in drug design and development, finding new targets to treat disease; mechanism of drug designing

ii. To understand the concept of molecular modeling, mechanics and interactions

iii. To provide clear concepts on bond angle, bond stretching, bond distance and role on different types of bonds in interactions

iv. To study about protein structure prediction and conformational changes throughout the simulation

v. To provide brief idea of receptor and receptor-ligand complex, inhibition and inactivation of enzyme, receptor theories

Course Outcomes:

i. The students would know the steps for designing new drugs, target identification and validation
ii. They would be able to apply concepts of molecular modeling, quantum and molecular mechanics, bond and bond angles in molecular interactions, energy concepts and its importance in drug action
iii. They would be able to perform protein structure prediction, loop searching, generating methods and analysis
iv. They would be able to understand the concepts of molecular dynamics with constant temperature, pressure, time-dependent properties and solvent effects
v. They would be able to perform drug designing basis on structure, ligand and De novo, screening types
vi. They would be able to understand the theory of inhibition and inactivation of enzymes, drug deactivation and susceptibility

Teaching Methods: The mode of teaching is based on the following learning activities:

- Lectures covering the theoretical part will be delivered using PowerPoint presentations.
- A set of laboratory exercises to analyze biological problems using softwares and tools to develop student's interests in scientific discovery.
- Case studies in informatics-based research.

Grading System

< 50 Marks in all	50 < Obtained Marks < 59	60 < Obtained Marks < 75	Obtained Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination on the whole syllabus for 75 Marks.

Attendance: The students are expected to attend the classes regularly, since regular attendance is essential to gain academic achievement. As per the University norms, the students having a minimum scale of 70-75% attendance are only qualified to write their end-semester examinations.

Punctuality: Punctuality is the most important quality for the student to be followed and maintained to achieve success. Students who arrive late by 10 mins to the class without any vital reason will be marked absent in the attendance register. On the other hand, valid excuse including personal or medical emergency is acceptable, with prior consent by the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking practice and much more that will provide a wholesome enriched classroom experience. When students participate, they learn from one another and gain their knowledge better.

Submission of Assignment: Assignments are given to students in order to apply the concepts for deeper understanding of the subject. Therefore, each student will be allocated

two assignments for the course, covering the entire topic. Students will be given deadline to submit the assignment by the course instructor and good preparation of assignment will help the students for their final exams.

Presentation of Seminar: Apart from the assignments, students are supposed to give an oral presentation during the class seminar hours in their assigned topic. The concerned instructor will encourage the participants to ask valid questions during seminar presentation in order to put up their confidence levels and communication skills. In addition, students will be able to gain information and can be updated in their course.

Preparedness: At the end of every class, the concerned instructor conveys the students about the details that will be handled in the next class to increase the student's awareness related to the topics.

Academic Dishonesty: Academic dishonesty is a completely unacceptable mode of conduct and every student should be aware of this important aspect. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Depending upon the requirement of student's possibility, the course syllabus will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairperson.

Important dates: Scheduled dates for the various activities related to the course

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test I	

Course Outline: Molecular Modeling and Drug Design (5 Credits)

- Role of Bioinformatics in drug design, Target identification and validation, lead optimization and validation, Structure-based drug design and ligand based drug design.
- Concepts in Molecular Modeling: Introduction; 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

- Homology modeling, concepts of homology modeling, secondary structure prediction methods: Threading, *ab initio* structure prediction Protein folding and model generation; analyzing secondary structures; Protein loop searching, loop generating methods, loop analysis.
- Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time dependent properties; Solvent effects in Molecular Dynamics; Conformational changes in Molecular Dynamics.
- Structure and Ligand based Drug Design: Pharmacophore identification, methods to identify lead compounds, Molecular Docking, *De-novo* ligand design methods, Applications of 3D Database Searching in Molecular docking. Random Screening, Virtual Screening, HTVS, QSAR, Target identification and Validation.
- Receptorology: Drug-receptor interactions, receptor theories and drug action. Theories of enzyme inhibition and inactivation; Enzyme activation of drugs and prodrugs. Drug like molecules and theories associated with the recognition of drug like properties. Physical organic chemistry of drug- metabolism, drug deactivation and elimination; Phase-I and phase-II transformations; Concept of hard and soft drugs; Chemistry of ADME and toxicity properties of drugs. Lipinski rule.

More books for Reading and Referencing

Pharmacoinformatics and Drug Discovery Technologies: Theories and Applications **Tagelsir Mohamed Gasmelseid** Publisher: Idea Group, 2012. **ISBN: 978-1466603097**
Molecular Modelling for Beginners - **Alan Hinchliffe** Publisher: John Wiley & Sons Inc, 2008. **ISBN: 978-0470513149**
Molecular Modeling. Basic Principles and Applications - **Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers** Publisher: Wiley-VCH, 2008. **ISBN: 978-3527315680**
Molecular Modeling Basics - **Jan H. Jensen** Publisher: CRC Press, 2010. **ISBN 978-1420075267**
Molecular Modeling and Simulation: An Interdisciplinary Guide - **Tamar Schlick** Publisher: Springer-Verlag New York, 2002. **ISBN: 978-1441963505**

Computational Chemistry and Molecular Modeling - **K. I. Ramachandran, Gopakumar Deepa, Krishnan Namboori**

Publisher: Springer – Verlag Berlin Heidelberg. 2008. **ISBN: 978-3540773023**

Molecular Modeling and Drug Design (5 Credits)

Syllabus	Schedule
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	**4 Days**
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.	**3 Days**
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.	**3 Days**
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.	**3 Days**
Unit-V	**2 Days**

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.	
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance	**8 days**

Assignment & Seminar – Molecular Modeling and Drug Design (502202)

1. Role of Bioinformatics in drug design
2. Structure Based Drug Design
3. Coordinate System
4. Quantum Mechanics
5. Energy concept and its importance in drug action
6. *Ab initio* method of structure prediction
7. Solvent effects in Molecular Dynamics
8. Application of 3D Database searching in Molecular Docking
9. Receptor theories and drug action
10. Concept of Hard and Soft drugs

Code: 502203 Computational Biology

Program: M.Sc., Bioinformatics	Semester : II (2019-20)
Course Title: **Computational Biology** (502203)	Class Time: 10-1: Monday 2-3 : Wednesday 4-5 : Thursday
Name of Course Teacher	Dr. P. Boomi
Mobile: +91-9486031423	Email : pboomi1983@gmail.com
Name of Course Teacher	Dr. V.K. Langeswaran
Mobile: +91- 98844 95511	Email : dr.langeswaran@gmail.com

Course Brief:

The course will cover topics of Computational Biology and Bioinformatics. Students will be introduced to computational modelling of cellular processes and some techniques for analysing these models to develop student research skills in the area of computational biology. It helps to develop working knowledge of computational techniques and their applications to biomedical research. Students will be empowered with fundamental new understandings of biological mechanisms related to the field of biological and medical sciences. Computational techniques are needed to analyze genome sequences, protein structures, metabolic and regulatory pathways, evolutionary patterns and the genetic basis of diseases. Students will also be introduced to some key problems in bioinformatics, the models used to formally describe these problems, and algorithmic approaches used to solve them. This course is designed to benefit students to understand the principles of analyzing biological data, building models and testing hypotheses related to computational and experimental works.

Text / Reference Books:

Text Books:

1. S. Aluru, (2005) "Handbook of Computational Molecular Biology"; Publisher- CRC Press.
2. C. Voigt, (2011) "Synthetic Biology: Methods for part/device characterization and chas-sis engineering" Academic Press.
3. J-L. Prugnaud, J-H.Trouvin, (2012) "Biosimilars: A New Generation of Biologics"; Publisher-Springer Science & Business Media.

Reference Books:

1. M.S. Waterman, (1995) "Introduction to Computational Biology: Maps, Sequences and Genomes"; Publisher-CRC Press.
2. K.I. Ramachandran, G. Deepa, K. Namboori, (2005) "Computational Chemistry and Molecular Modeling: Principles and Applications"; Springer.
3. B. Haubold, T. Wiehe, (2006) "Introduction to Computational Biology: An Evolutionary Approach"; Publisher-Springer Science & Business Media.
4. K. Najarian, S. Najarian, S. Gharibzadeh, C.N. Eichelberger, (2009) "Systems Biology and Bioinformatics: A Computational Approach"; Publisher- CRC Press.
5. C. Voigt, (2011). "Synthetic Biology, Part B: Computer Aided Design and DNA Assembly. Meth-ods in enzymology"; Elsevier Science.

6. H. J. Gutka, H.Yang, S. Kakar, (2018) "Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development"; Publisher-Springer.

Course Objectives: The students shall be able to

i. To provide students with the basic knowledge of biosimilar, computational biology and their advances of synthetic biology, more specifically:

ii. This course will provide the basic information about biosimilar with their clinical and non clinical aspects.

iii. This course will facilitate the students to attain skills in basic computational biology that are essential for various biomedical applications.

iv. The students can able to understand the different alignment and their problems.

v. This course will give the various methods of Sequence matching.

vi. The students will also be able to perform Multiple sequence alignment.

vii. The students will learn about advanced computational biology using synthetic biology and quantum mechanics.

Course Outcomes:

i. Students will obtain basic knowledge about the biosimilar and can learn about clinical approach of biosimilar
ii. Student should be able to gain the computational biology and comparison of matrices.
iii. Student would able to describe the sequence matching analysis and dynamic programming methods.
iv. Students will gain the how to alignment the sequence using computational approach.
v. Students will develop the knowledge of advanced computational biology using synthetic biology and quantum mechanics using different theory.
vi. Students will be aware of current research and problems relating to this area and will be able to complete a project in bioinformatics using databases, current data analysis techniques and the development of appropriate computer software.

Teaching Methods: The mode of teaching is based on the following learning activities:

- Lectures covering the theoretical part will be delivered using PowerPoint presentations.
- A set of laboratory exercises to analyze biological problems using softwares and tools to develop student's interests in scientific discovery.
- Case studies in informatics-based research.

Grading System

< 50 Marks in all	50 < Obtained Marks < 59	60 < Obtained Marks < 75	Obtained Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, seminars, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: The students are expected to attend the classes regularly, since regular attendance is essential to gain academic achievement. As per the University norms, the students having a minimum scale of 70-75% attendance are only qualified to write their end-semester examinations.

Punctuality: Punctuality is the most important quality for the student to be followed and maintained to achieve success. Students who arrive late by 10 mins to the class without any vital reason will be marked absent in the attendance register. On the other hand, valid excuse including personal or medical emergency is acceptable, with prior consent by the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking practice and much more that will provide a wholesome enriched classroom experience. When students participate, they learn from one another and gain their knowledge better.

Submission of Assignment: Assignments are given to students in order to apply the concepts for deeper understanding of the subject. Therefore, each student will be allocated two assignments for the course, covering the entire topic. Students will be given deadline to submit the assignment by the course instructor and good preparation of assignment will help the students for their final exams.

Presentation of Seminar: Apart from the assignments, students are supposed to give an oral presentation during the class seminar hours in their assigned topic. The concerned instructor will encourage the participants to ask valid questions during seminar presentation in order to put up their confidence levels and communication skills. In addition, students will be able to gain information and can be updated in their course.

Preparedness: At the end of every class, the concerned instructor conveys the students about the details that will be handled in the next class to increase the student's awareness related to the topics.

Academic Dishonesty: Academic dishonesty is a completely unacceptable mode of conduct and every student should be aware of this important aspect. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Depending upon the requirement of student's possibility, the course syllabus will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairperson.

Important dates: Scheduled dates for the various activities related to the course

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test I	

Course Outline: Core: Computational Biology- (502203) (5 Credits)

- String algorithms are a traditional area of study in computer science in recent years- algorithms in bioinformatics – sequences algorithms on strings, trees and protein sequences can be represented as strings over finite.
- Shortest path algorithm-Hamiltonian Path for graph representation-Maximum flow.
- Comparative genomics: Orthologues and paralogues, xenologues (horizontal gene transfer); Non-orthologous gene displacement; Analogues; Orthologue identification by BLAST and reciprocal best hit.
- Use of comparative genomics in gene annotation, and function prediction; Phylogenetic foot printing; Gene order.
- Details of Needleman - Wunsch and Smith- Waterman algorithms-BLAST and FASTA applications.
- Web based servers and softwares for genome analysis: Ensembl, NCSC genome browser, NCBI genome.
- Hierarchical alignment with worked out examples of substitution matrices- PAM substitution matrices - BLOSUM substitution matrices.
- Hidden Markov models and application to analyze of protein and genome sequences.

- Methods of representing biological molecules – geometrical analyses – Protein Structure Comparison and Classification- different classes of Protein interactions.

More books for Reading and Referencing

Understanding Bioinformatics - **Marketa Zvelebil, Jeremy Baum** Publisher: Garland Science, First edition, 2007. (**ISBN: 978-08-153-4024-9**)
Bioinformatics and Functional Genomics - **Jonathan Pevsner** Publisher: Wiley-Blackwell, Third edition, 2015. **(ISBN: 978-11-185-8178-0)**
Practical Computing for Biologists - **Steven Haddock, Casey Dunn** Publisher: Sinauer Associates, Inc.; First edition, 2010. **(ISBN: 978-08-789-3391-4)**
Introduction to Computational Biology: An Evolutional Approach - **Bernhard Haubold, Thomas Wiehe** Publisher: Springer (sie) (2008). **(ISBN: 978-37-643-7387-0)**
Algorithms on strings, trees, and sequences: computer science and computational biology- **Dan Gusfield** Publisher: Cambridge University Press, 1997. **(ISBN: 978-05-215-8519-4)**
Bioinformatics: A biologist's guide to biocomputing and the internet -**Stuart M. Brown** Publisher: Eaton Publishing, 2000. **(ISBN: 188129918X, 9781881299189)**

Computational Biology (5 Credits)

Syllabus	Schedule
Unit-I **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.	**12 days**
Unit-II	**10 days**

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-III **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.	**14 days**
Unit-IV **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.	**12 days**
Unit-V **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 Quantum Mechanics**- One electron atoms, Polyelectron atoms and molecules, Molecular orbitals, Hartree-Fock Equations, Molecular Properties using ab initio methods, Semi-empirical methods, Huckel Theory.	**12 days**
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance.	**5 days**

Assignment & Seminar – Computational Biology (502203)

1. String operation and classification of algorithms
2. Write down the difference of PAM250 and BIOSSM62 matrix.
3. List out the hierarchical classifications of proteins.
4. Hidden Markov models and its application
5. Use of comparative genomics in drug discovery programs.

6. Protein Interaction analysis
7. Write a note on Sequence pattern representations.
8. How will you predict gene using Fourier analysis.
9. Describe the statistics to estimate significance of an alignment.
10. Briefly explain the dynamic programming for multiple sequence alignment.

Code: 502204 Programming in Scripting Languages (PYTHON, PERL & R)

Program: M.Sc.,	Semester: II (2019-20)
Course Title and Code: **Programming in Scripting Languages (PYTHON, PERL & R)** (502204)	Class Time: 2-5: Monday 12-1: Thursday
Name of the Course Teacher	Dr. RM. Vidhyavathi
Mobile: +91 - 9444835869	Email: vidhyamiss@gmail.com

Course Brief:

Perl is a general-purpose programming language originally developed for text manipulation and now used for a wide range of tasks including system administration, web development, network programming, GUI development and more.

Python is a language with a simple syntax, and a powerful set of libraries. It is an interpreted language, with a rich programming environment, including a robust debugger and profiler. While it is easy for beginners to learn, it is widely used in many scientific areas for data exploration. This course is an introduction to the Python programming language for students without prior programming experience. We cover data types, control flow, object-oriented programming, and graphical user interface-driven applications. The examples and problems used in this course are drawn from diverse areas such as text processing, simple graphics creation and image manipulation, HTML and web programming, and genomics.

R is rapidly becoming the leading programming language in statistics and data science. R programming builds the proficiency in using R programming language for statistical computing and graphics. R, a language and environment, is gaining popularity in

getting insight in complex data. The business analyst and other professionals dealing in large amount of data can derive results using the ready-made functions available in R.

Reference/Text Books:

Text Books:

1. Perl Larry Wall, Tom Christiansen, & Randal Schwartz, (2012) "Programming Perl", O-Reilly, Fourth Edition.
2. Hans Petter Langtangen, (2006)," Python Scripting for Computational Science", Springer Science & Business Media.
3. Seema Acharya, (2018), "Data Analytics Using R", McGraw Hill Education, First edition.

Reference Books:

1. David Till, (1996),"Teach Yourself Perl 5 in 21 days ", Sams Publishing, Second Edition.
2. Tom Christiansen & Nathan Torkington, (1998),"Perl Cookbook", O'Reilly Media First Edition.
3. Kaladhar DSVGK, (2014),"Basics in PERL and BioPERL", GRIN Verlag**.**
4. Jeff Chang, Brad Chapman, Iddo Friedberg, Thomas Hamelryck, (2017),"Biopython Tutorial and Cookbook".
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, (2016), "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd.
6. Timothy A. Budd, (2015) "Exploring Python", Mc-Graw Hill Education (India) Private Ltd.
7. Guido van Rossum and Fred L. Drake Jr. (2011), "An Introduction to Python – Revised and updated for Python 3.2", Network Theory Ltd.
8. Sandip Rakshit, (2017) "R Programming for Beginners", McGraw Hill Education, First Edition
9. Jared P. Lander, (2018) "R for Everyone: Advanced Analytics and Graphics", Pearson Education, Second edition

Course Objectives: To make the students:

The course presents basics of MYSQL and PERL programming Scalar data, Numbers, Strings, Variables, Operators, Hierarchy of operators and Variable interpolation. And also it discusses the Basic i/o functions, Making decisions, Loops, Functions, Lists & Arrays and Conditional blocks.

i. To introduce students to pros and cons of scripting vs. compiled programming languages.
ii. Understand the syntax and semantics of the Perl language and their similarity and differences from Java.
iii. How to develop and implement various types of programs in the Perl language
iv. Understand various forms of data representation and structures supported by the Perl language
v. To expose students to applications where Python programming is effective (e.g. application development, scripting, systems administration)
vi. To give students a thorough understanding of the Python programming language and it's rich set of libraries.
vii. Recognize similarities and common characteristics of programming languages.
viii. identify appropriate statistical methods for the data or problems and conduct their own analysis using the R environment
ix. R can interface with other languages (e.g. Python, C/C++) when tasks require increased speed and computational power.

Course Outcomes: The students shall be able to

i. Understand the concepts of object-oriented programming as used in Python: classes, subclasses, inheritance, and overriding. Understand the basics of OO design.
ii. Have knowledge of basic searching and sorting algorithms, and knowledge of the basics of vector computation. (k)
iii. Understand the pros and cons on scripting languages vs. classical programming languages (at a high level)
iv. Proficient programming in the Perl language and programming in general.
v. Design and revision of Perl scripts.
vi. Debugging techniques appropriate for the Perl language.
vii. Understand principles of Python.
viii. List motivation for learning a programming language and Access online resources for R and import new function packages into the R workspace.
ix. Import, review, manipulate and summarize data-sets in R.
x. Explore data-sets to create testable hypotheses and identify appropriate statistical tests.

xi. Perform appropriate statistical tests using R.
xii. Create and edit visualizations with R.

Teaching Methods: The course will be used on the basis of the following teaching and learning methods:

- Lectures covering the theoretical part using PowerPoint presentations
- Case studies
- Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 60	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class/Lab Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Core: Programming in Scripting Languages (PYTHON, PERL & R)

- Concepts about Regular Expressions, Simple Uses of Regular Expressions, Patterns, More on the Matching Operator, Substitutions, The split and join Functions.
- Object oriented Perl consist-Introduction to modules and Creating Objects.
- The BioPerl keeps Installation procedures, Architecture and that uses.
- Conceptual introduction: installing Python, basic syntax, interactive shell, editing, saving, and running a script.

- The concept of data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages.
- Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation.
- String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers.
- Understand interpreter and compilers: CPython, PyPy, Cython.
- See demonstration of IDE's: IDLE, IPython, IPython Notebook, hosted environments.
- Clear understanding of Statistical programming and R environment
- In-depth knowledge of basic features, functions, operators available with R
- Comprehensive information about programming statistical graphics
- Ways of using simulation and numerical optimization
- Extract data from R objects, perform reading and writing of Data, and handle databases
- Use subscripting, character manipulation, and reshaping of data
- Find probability, distributions, regression and correlation
- Significance of sample size and its calculation
- Advance data handling technique

More books for Reading and Referencing

MySQL and Perl for the Web, Paul DuBois, **ISBN-10:** 0735710546,Wynand S. Verwoerd; 2001 **ISBN:** 978-87-403-0251-6.
Programming the Perl DBI, By Tim Bunce, Alligator Descartes and Publisher: O'Reilly Media, 2000 **ISBN**: 978-1-56592-699-8, | ISBN 10: 1-56592-699-4.
Developing Web Applications with Apache, MySQL, memcached, and Perl, Patrick Galbraith, 2009 **ISBN**: 978-0-470-41464-4.
The Fundamentals of Python: First Programs- Kenneth A. Lambert, Cengage Learning, 2011. **ISBN:** 978-1111822705.
R Programming for Bioinformatics, Robert Gentleman, CRC Press,2008, **ISBN:** 1420063685, 9781420063684

Programming in Scripting Languages (PYTHON, PERL & R)
(5 Credits)

Syllabus	Schedule
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.	**9 days**
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.	**9 days**
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	**10 days**
Unit-IV **Python-Lists, Tuples, and Dictionaries: Lists:** operations, slices, methods, loop, mutability, aliasing, cloning, parameters, **Tuples:** assignment, tuple as	**13 days**

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.	**10 days**
CIA Tests, Seminars, Presentations, Reviews, Assignments, Journal club and Career Guidance.	**5 days**

Practical, Assignment & Seminar PROGRAMMING in Scripting Languages (PYTHON, PERL & R) (502204)

1. Decision making process in PERL programming.
2. Illustrates Regular Expressions with an example.
3. Discuss in detail about CGI Programming.
4. Describe about Database Manipulation
5. Program to string processing in sub-routines
6. Convert a DNA fast a file to RNA fasta file (using File Handling)
7. CGI-Perl program to submit a DNA sequence and validate the sequence
8. CGI-Perl program to perform the Translation process for user given sequence
9. Types of Operators in python Programming with an Example.
10. Chained conditional (if-elif-else), state, while, for, break, continue, pass, Fruitful.
11. Tuple assignment, tuple as return value.
12. Files and exception handling and its Packages.
13. Database search using Biopython.
14. Debugging and Object Oriented Programming, Loop Functions, Data Analytics.
15. Structures and Functions, Loop Functions of R.

Code: 502205 Lab-II Molecular Biology and Biochemical Techniques

Program: M.Sc.,	Semester : II (2019-20)
Course Title: **Lab – II Molecular Biology and Biochemical Techniques** (502205)	Class Time: 2-5: Tuesday 10-12: Thursday
Name of Course Teacher	Dr. M. Karthikeyan
Mobile: +91 - 94869 81874	Email: mkbioinformatics@gmail.com
Name of Course Teacher	Dr. J. Joseph Sahayarayan
Mobile: +91 - 90475 64087	Email: jjsrbioinformatics2016@gmail.com
Name of Course Teacher	Dr. V.K. Langeswaran
Mobile: +91 - 98844 95511	Email: dr.langeswaran @gmail.com
Name of Course Teacher	Teaching Assistant

Course Brief:

This course begins with a review of basic bio-analytical technique and an introduction to general terminologies along with their theory, working principles, common instrumentation and possible applications which will be equally beneficial to various scientific areas including, life science, chemical science, material science and environmental science.

Understanding of molecular structure & function is of central importance to students undertaking a major biological or chemical field. This course focuses on concepts of DNA/RNA, protein, lipid & carbohydrate comprehending the aspects from structure to function. Some content and assignments are based on current literature describing recent DNA, protein structures and how structure can be utilized to conclude the function of it. Laboratory work will emphasize the techniques required to analyze biomolecules. Students will integrate theoretical knowledge with experimental data.

Reference/Text Books:

Text Books:

1. John M. Walker and Ralph Rapley, (2002) “Molecular Biology and Bio technology”; University of Hertfordshire, Hatfield, UK, Fourth Edition
2. Bansal, M. P. (2013) “Molecular Biology and Biotechnology”: Basic Experimental Protocols, New Delhi: TERI.

Reference Books:

1. R.H. Burdon, P.H. Van Knippenberg, (1990) "Laboratory techniques in Biochemistry and Molecular biology"; Elsevier Amsterdam. New York. Oxford, Second Edition, volume 8.
2. Rodney and Royer, (2004) "Modern Experimental Biochemistry"; Pearson education, India.
3. Hans-Walter Heldt, (2004) "Plant Biochemistry"; Elsevier Academic Press, Third edition.
4. James M. Miller, (2005) "Chromatography: Concepts and Contrasts"; Wiley-Interscience, Second Edition.
5. Richard I. Gumport, Jeremy M. Berg, Nancy Counts Gerber, (2006) "Biochemistry- A Student Companion"; I.K. International Pvt, Ltd. Sixth edition.
6. Eisenthal, R. and Danson, M.J. (2006) "Enzyme assays"; Oxford University Press.
7. Donald Voet, Judith G. Voet, (2010) "Biochemistry"; John Wiley & Sons Inc; 4 Edition.
8. Keith Wilson, John Walker, (2010) "Principles and Techniques of Biochemistry and Molecular Biology"; Cambridge University Press; 7 Edition.
9. Michael R. Green, Joseph Sambrook, (2012) "Molecular cloning: a laboratory manual"; Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory Press, 4th Edition.
10. Michael M. Cox, Michael O'Donnell, Jennifer Duodena, (2015) "Molecular Biology: Principles and Practice Hardcover"; WH Freeman; 1st Edition.
11. David L. Nelson, Michael, (2017) "Lehninger Principles of Biochemistry: International Edition, WH Freeman, 7th Edition, ISBN: 9781319108243, 1319108245.

Course Objectives: To make the students:

1. Experimental design and hypothesis testing.
2. Data interpretation, including standard curve interpolation (graphing) and determining molecular weight of an unknown protein or genotype.
3. Genetic engineering in microorganisms (e.g., bacteria, yeast). DNA analysis, including DNA extraction, use of restriction enzymes.
4. Identification of genetic inheritance patterns based on genotype and phenotype including sex-linked traits.
5. Microscopy procedures and identification of cellular components.

Course Outcomes: The students shall be able to:

i. Carry out various types of practical laboratory work (chemical, biochemical and molecular genetics) in a safe way by means of oral and written laboratory instructions and be able to analyze, interpret and present the results with theoretical background in forms of different laboratory reports.
ii. Students will explain/describe the synthesis of proteins and nucleic acids their role in metabolic pathways along with their regulation at the epigenetic, transcriptional, translational, and post-translational levels including RNA and protein folding, modification, and degradation. Regulation by non-coding RNAs will be tied to the developmental and physiological functioning of the organism.
iii. Students will analyze structure-function relationships of genes and proteins from bacteria to eukaryotes using genomic methods based on evolutionary relationships.
iv. Students will use current biochemical and molecular techniques to plan and carry out experiments.
v. They will generate and test hypotheses, analyze data using statistical methods where appropriate and appreciate the limitations of conclusions drawn from experimental data.
vi. Master various methods for gene cloning, mutagen zing DNA and protein sequences. Methods for analysis of gene expression.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions
- Case-studies and Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks	**End-Semester Exam: 75 Marks**

3 hour test for 75 marks and then is converted to 15 marks	Assignments and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics

that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Lab-II: Molecular Biology and Biochemical Techniques (3 Credits)

1. Collect samples from environment.
2. Extract and purify DNA from collected samples.
3. Use PCR to amplify specific regions from the chloroplast or mitochondrial DNA that are short but highly variable.
4. Analyze the proteins by using various Chromatographic methods.
5. Analyze PCR product by agarose-gel electrophoresis.
6. Use BLAST to identify sequences in database to taxonomically assign the sample.
7. PCR using primers specific for identification of species.
8. Construct genomic DNA libraries from wild-type.
9. Isolate plasmid DNA from surviving clones and obtain DNA sequence to identify the mutated gene.
10. Use bioinformatics to determine sequence differences between wild-type and mutant strains and compare to sequences recovered by functional complementation.

More books for Reading and Referencing:

Biochemical Calculations Paperback by Irwin H. Segel, 2010 **ISBN: 10: 8126526432; ISBN: 13: 978-8126526437**
Laboratory Manual of Biochemistry: Methods and Techniques by R. S. Sengar, 2014 **ISBN: 10: 9383305029**

Student Solutions Manual for Molecular Cell Biology by Harvey Lodish, 2012
ISBN: 13: 978-1464102301

Lab-II: Molecular Biology and Biochemical Techniques (3 Credits)

Syllabus	Schedule
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.	**14 days**
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.	**10 days**
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).	**8 days**
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.	**10 days**
Unit-V **Microscopes and immune techniques:** Microscopes and immune	**14 days**

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).	
CIA Tests, Seminars, Presentations, Assignments, Journal club and Career Guidance.	**5 days**

Assignment, Seminar & Practicals – Biochemical and Molecular Biology Techniques (502205)

1. Quantification of proteins by Lowry's and Bradford's methods.
2. Preparation of reagents buffers and adjust pH.
3. Acquisition of basic laboratory techniques.
4. Working under sterile conditions.
5. Isolation, separation and analysis of Proteins by Native-PAGE and SDS-PAGE
6. Pipetting.
7. Primer Design.
8. Chromatography and its types.
9. Protein assay (standard curve).
10. RNA extraction.
11. DNA isolation conventional PCR.
12. Blotting techniques.

SEMESTER –III

Code: 502301 Genetics and Genetic Engineering

Program: M.Sc.,	Semester : III (2019-20)
Course Title: **Genetics and Genetic Engineering (502301)**	Class Time: 2-5: Monday 2-4: Friday
Name of Course Teacher	Dr. J. Joseph Sahayarayan

Course Brief:

Genetic and Genetic Engineering, also called "Recombinant DNA technology" is one of the main branches of biological sciences that deal with the manipulation of genetic material of any organism. This important course will explain to the students to understand the mechanism of genetic changes, techniques used for genetic modifications. The course also highlights basic and advanced molecular techniques such as polymerase chain reaction (PCR), DNA sequencing-which covers conventional first generation sequencing technology (Sanger Sequencing) to high throughput second (Pyrosequencing & Illumina) and third sequencing technologies (Nanopore, SMRT sequencing), blotting techniques, chromosomal changes and DNA profiling. The proposed course will cover topics starting from manipulation of organisms at genome level to use of that organism at various fields including agriculture, medical and pharmaceutical industries.

Reference/Text Books:

Text Books:

1. Sandy B., Primrose and Richard Twyman. (2016). Principles of Gene Manipulation and genomics; Wiley-Blackwell. 7th Edition
2. Brown T. A. (2016). Gene cloning and DNA analysis, An introduction; Wiley-Blackwell, 7th edition.

Reference Books:

1. Watson, J. D, Gilman, M., Witkowski, J., and Zoller, M. (2007) Recombinant DNA: Genes and Genomes: A Short Course, W.H. Freeman and Co., New York, N.Y., U.S.A. 3rd Edition.
2. Gunder. (2010) Essentials of Medical Genetics Jones and Bartlett learning 1st edition.
3. Strachan T, and Read AP. (2012) "Human Molecular Genetics"; Garland Science Publisher 4th edition.
4. Bruce. R. Korf. (2013) Human Genetics and genome 4th edition kindle edition.
5. Jin Kim. (2017) Cancer Genetics and Genomics for Personalized Medicine 2nd edition.

Course Objectives: To make the students:

1. 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.

2. Knowledgeable in basic techniques of molecular biology and their applications in various aspects.

3. Versed in all application aspects of recombinant DNA technology like production of therapeutic products as well as use of this subject in diagnosis and treatment of inherited disorder and infectious disease.

Course Outcomes: The students shall be able to

A. Apply the basic principles of Mendelian genetics to single locus traits.

B. Adequate completion of non-graded homework problems in inheritance.

C. Participation in class discussion of problems in inheritance.

D. Recognize mechanisms of gene regulation and differences between prokaryotic and eukaryotic systems.

E. Understand the importance of enzymatic processes in maintenance of genetic fidelity.

F. Students will apply the principles of natural selection to problems in population genetics.

G. Students will understand the role of various natural DNA alterations in generation of genetic variability.

H. Adequate completion of non-graded homework problems in population genetics.

I. Participation in class discussion of problems in variability and selection.

J. Students will design hypothetical gene cloning experiments.

K. Students will understand the molecular basis of regulated gene expression in coordinating biochemical and developmental processes in both unicellular and multicellular organisms.

L. Adequate completion of non-graded homework problems in recombinant DNA technology.

M. Participation in class discussion of problems in gene manipulation.

N. Passing grade on midterm/final containing problems in inheritance, DNA metabolism, evolution and molecular genetics.

Course Outcomes: The students shall be able to

i. Apply the basic principles of Mendelian genetics to single locus traits.
ii. Adequate completion of non-graded homework problems in inheritance.
iii. Participation in class discussion of problems in inheritance.
iv. Recognize mechanisms of gene regulation and differences between prokaryotic and eukaryotic systems.
v. Understand the importance of enzymatic processes in maintenance of genetic fidelity.

vi. Students will apply the principles of natural selection to problems in population genetics.
vii. Students will understand the role of various natural DNA alterations in generation of genetic variability.
viii. Adequate completion of non-graded homework problems in population genetics.
ix. Participation in class discussion of problems in variability and selection.
x. Students will design hypothetical gene cloning experiments.
xi. Students will understand the molecular basis of regulated gene expression in coordinating biochemical and developmental processes in both unicellular and multicellular organisms.
xii. Adequate completion of non-graded homework problems in recombinant DNA technology.
xiii. Participation in class discussion of problems in gene manipulation.
xiv. Passing grade on midterm/final containing problems in inheritance, DNA metabolism, evolution and molecular genetics.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions
- Case-studies and Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination on the whole syllabus for 75 Marks.

to 15 marks		

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

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Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

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Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Core: Genetics and Genetic Engineering (4 credits)

1. Understand and think about the basics of Genetic and Genetic Engineering.
2. To understand the role, use and types of different DNA modifying enzymes viz. Polymerases, Nucleases, restriction endonuclease, ligases etc.
3. Acquire basic knowledge of DNA sequencing methods from conventional (Sanger sequencing) to High throughput Next generation sequencing technology, their principle, chemistry, theory and types.
4. Syllabus will also provide plethora of information to students regarding basic molecular biology techniques like blotting and its different types, DNA foot printing as well as description of industrial application of genetic engineering Technology, therapeutic and enzymatic products and deployment of Genetics and Genetic Engineering in diagnosis and disease.

More books for Reading and Referencing:

An Introduction to genetic engineering third edition – Desmond S.T.Nicholl
Genetic Engineering (Oxford Higher Education) Paperback – 8 Jul 2009
Genetic Engineering Paperback – 1 Jul 2017 by Sandhya Mitra

Genetics and Genetic Engineering (502301) (4 Credits)

Syllabus	Schedule
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.	**10 days**
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.	**10 days**
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.	**12 days**
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.	**8 days**
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,	**16 days**

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.	
CIA Tests, Seminars, Presentations, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar – Genetics and Genetic Engineering

1. Mendel's experiments.
2. Sex linked inheritance.
3. Pedigree Analysis.
4. Types of mutation.
5. Blood groups, Rh factor in Human, Epistasis.
6. Genome organization of Prokaryotic and Eukaryotic cell, Regulation of translation, Post transcriptional modifications.
7. Mechanism of genome alteration.
8. Chromosomal abnormalities.
9. Oncogenes, Tumor suppressor genes.
10. Selectable markers, abiotic and biotic stress resistance, fruit ripening, edible vaccines.

Code: 502302 Structural Biology

Program: M.Sc.,	Semester: III (2019-20)
Course Title and Code: **Structural Biology (502302)**	Class Time: 10-11 : Monday 10-1: Thursday
Name of the Course Teacher	Prof. J. Jeyakanthan
Mobile: +91 - 97898 09245	Email: jjkanthan@gmail.com

Course Brief:

Protein structure forms a central hub to the modern understanding of biological processes and is used in various biotechnological applications including the design of medicines and vaccines, agrochemicals and enzymes for industrial processes. This course aims to extend the discussions on protein structure and function present in microbes, insects, animals and human models and to use this knowledge to gain an understanding of the essential processes of molecular biology. The course covers two principle themes:

Small molecular X-ray crystallography: topics include Crystal growth and its techniques, Crystallization of synthetic compounds, X-ray data collection and direct methods to refine the structure. Macromolecular X-ray crystallography topics include - structure and function of different classes of proteins, cloning, expression, purification, crystallization, data collection and structure solution/ determination. Protein folding, Protein degradation, development of new therapies, molecular interactions and recognition are covered in this syllabus.

Reference(s)/Text Books:

Text Books:

1. Giacovazzo, C. Monaco, H.L. Artioli, G. Viterbo, D. Milanesio, M. Ferraris, G. Gilli, G. Gilli, P. Zanotti, G. Catti, M. (2011) “Fundamentals of Crystallography - Third Edition”; International Unioin of Crystallography; Oxford [u.a.]: Oxford Univ. Press, Oxford Science Publications
2. Carl Branden and John Tooze (1991) “Introduction to Protein Structure”: Garland Publishing Inc
3. Amit Kessel and Nir Ben Tal (2018). "Introduction to Proteins. Structure, Function and Motion - Second Edition"; CRC Press - Taylor and Francis Group.
4. Toshiya Senda and Katsumi Maenaka (2016). "Advanced Methods in Structural Biology"; Springer.
5. Bernhard Rupp (2010). "Biomolecular Crystallography - Principles, Practice and Application to Structural biology"; GS - Garland Science - Taylor and Francis Group.

Reference Books:

1. George H. Stout, Lyle H. Jensen (1989) “X-Ray Structure Determination”: John Wiley & Sons
2. Jan Drenth (1994) “Principles of Protein Crystallography”; Springer-Verlag New York, Inc
3. Bourne, P. E. & Weissig, H. (2003) “Structural bioinformatics”; Wiley-Liss
4. Christopher Hammond (2009) “The Basics of crystallography and diffraction” Oxford.
5. Liljas, A., Liljas, L., Piskur, J., Lindblom, G. Nissen, P. Kjeldgaard, M. (2009) “Textbook of structural biology”; Hackensack, N.J. World Scientific.
6. Dmitri I. Svergun (2013) “Small angle X-Ray and neutron scattering from solutions of biological macromolecules” Oxford.

7. Marcus Frederick Charles Ladd and Rex Alfred Palmer, (2013), Structure Determination by X-ray Crystallography, Springer.
8. David Blow., and Jan Denth (2014) " Macromolecular crystallography"
9. Li-ling Ooi, (2014), Principles of x-ray crystallography, Oxford University Press
10. F. C. Philips "An Introduction to Crystallography", Cambridge

Course Objectives: To make the students:

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.

iii. Computational approach of structure and function relationships of biomolecules.

iv. Structure-based design of new molecules that are vital to identify its therapeutic impacts by making a thorough detailed study on its atomistic structure make-up and its correlation with function delivered in biological process.

Course Outcomes: The students shall be able to

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.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions
- Case-studies and Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, seminars reviews, and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

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Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

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Important dates: Please note down the important dates and stick to the schedule

CIA Test I	II CIA Test	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Structural Biology (5 credits)

- **Small molecular X-ray crystallography:** include Crystal growth and its techniques, Crystallization of synthetic compounds - X-ray data collection and direct methods to refine the structure.
- **Macromolecular X-ray crystallography:** include structure and function of different classes of proteins, cloning, expression, purification, crystallization, data collection and structure solution/ determination.
- Tools for model building and refinement.
- Structural data repositories: Protein Data Bank, Electron Microscopy Data Bank.
- Tools for homology modeling: WHATIF, AutoRickshaw, ARP/wARP, and other software.
- Tools and resources for drug discovery: ChEMBL, GOLD for protein-ligand docking, PDBeChem, PDBeMotif.
- Tools and resources for protein analysis and classification: Pfam, CATH, SCOP, InterPro, PDBeFold, ProFunc.

More books for Reading and Referencing

Macromolecular Crystallography with Synchrotron Radiation by John R. Helliwell; 2004, **ISBN:0521334675**

Principles of X-ray Crystallography by Li-ling Ooi; 2010, **ISBN:9780199539045**
International Tables for Crystallography, Volume C: Mathematical, Physical AND Chemical Tables edited by E. Prince, 2004, **ISBN:1-4020-1900-9**

Structural Biology (5 Credits)

Syllabus	Schedule
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	**3 days**
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.	**3 days**
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.	**6 days**
Unit IV: **Protein X-ray Crystallography**: Crystallization methods (sitting, hanging drop, microbatch methods etc.,), Soaking and Co-Crystallization	**10 days**

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.	**6 days**
CIA Tests, Seminars, Presentations, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar - Structural Biology (502302)

1. X-ray and its properties; X-ray generation diffraction and its applications.
2. Structure factor, Electron density calculations and phase problem.
3. Point group, Space group, Crystal systems and Symmetry.
4. Synchrotron radiation and its implications in structure determination.
5. NMR- Introduction and general aspects of structure determination.
6. Application of direct methods over Patterson method of solving a small molecule.
7. Protein structure determination methods - Molecular Replacement technique (MR), Single Isomorphous Replacement method (SIR), Multiple Isomorphous Replacement Method (MIR), Single wavelength Anomalous Diffraction method (SAD) and Multi wavelength Anomalous Diffraction method (MAD).
8. Application of X-ray crystallography in drug design.
9. Conformation of small and macromolecule structures and thermal motion analysis.
10. list out the places for Synchrotron and NMR facilities available for Protein Structure Determination.

Code: 502303 Pharmacogenomics

Program: M.Sc.,	Semester: III (2019-20)

Course Title and Code: **Pharmacogenomics** (502303)	Class Time: 2-3 and 4-5 : Wednesday 10-12 : Friday
Name of the Course Teacher	Dr. M. Karthikeyan
Mobile: +91 - 9486981874	Email: mkbioinformatics@gmail.com

Course Brief:

The course will provide an introduction to the application of genetic and genomic methods to the study of drug response and the genetic basis for variation in that response. It will give students a broad perspective on the emergence of Pharmacogenomics as a new field and provide them with insight into the growing importance it will play in clinical therapeutics and future drug design. The latest advancement in NGS sequencing will be much helpful to students to gain insights into Pharmacogenomics.

References/Text Books:

Text Books:

1. Falconer, D.S., Mackay, T.F.C., (1996) "Introduction to Quantitative Genetics". Pearson Education Ltd, 4th Ed
2. Yan, Qing. (2014). "Pharmacogenomics in Drug Discovery and Development"; Springer – Verlag, New York, LLC, 2nd Edition.
3. Yui-Wing, L Cavallari. (2013). "Pharmacogenomics-Challenges and Opportunities in Therapeutic Implementation" Academic Press, 1st Edition.

Reference Books:

1. Sankoff, D. & Nadeau, J.H. (2000) "Comparative genomics: empirical and analytical approaches to gene order dynamics, map alignment and the evolution of gene families"; Netherlands, Kluwer Academic Publishers.
2. Richard, J.R. (2003) "Analysis of Genes and Genomes"; Wiley Publications.
3. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis";2nd edition, Cold Spring Harbor Laboratory Press, New York.
4. Rapley, R. & Harbron, S. (2004) "Molecular analysis and Genome discovery"; John Willey & Sons, Ltd.
5. Russ B.Altman. (2012). "Principles of Pharmacogenetics and Pharmacogenomics", Cambridge University Press.

Course Objectives: To make the students:

i. To improve patient outcomes by maximizing efficacy and minimizing toxicity of drug therapy through research, teaching and service focused on genetically-guided drug therapy decision-making, drug discovery and drug development.
ii. 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.
iii. To help students to gain knowledge about the NGS technologies useful in Personalized drug designing.
iv. Case study examples and concepts will help students to understand the current scenario in therapeutic treatment.

Course Outcomes:

i. 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.
ii. 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.
iii. The genetic basis of variability in drug response can contribute to drug efficacy and toxicity, adverse drug reactions and drug-drug interactions
iv. Understanding of the basics of Pharmacogenomics will enable students to better understand and manage the new genomics based tools as they become available as well as make best treatment choices.
v. The next generation sequencing technology and its application will enhance the technical skills.
vi. It is hoped that by the end of the course, students will be able to read, understand and critique literature regarding Pharmacogenomics.
vii. In order to achieve its objectives, the course will utilize formal PowerPoint presentations, review of selected current literature, case studies, group discussions, and student presentations.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions
- Case-studies and Review questions

Grading System

<50 Marks in all	50< Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		End-Semester Exam: 75 Marks
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars, for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance has been taken will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	II CIA Test	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Core: Pharmacogenomics (4 Credits)

- Basic concepts of pharmacogenomics and genetics diseases.
- Pharmacogenomics necessity in drug designing.
- Polymorphisms and their importance in drug designing.
- Structural influence in the Drug response.

- Prediction of structural changes among sequences by the influence of polymorphisms.
- Tools for pharmacogenomic analysis. Pharmacokinetics (PK), Pharmacodynamics (PD).
- Target Structure optimization, Validation, lead identification, ADME prediction.
- Synthesis, assay, and clinical trials for the identification of novel drug.
- Allele-Specific Variation in Human Gene Expression and Genome-Wide Analysis of Allele-Specific Gene Expression.
- Expression study using Oligo Microarrays, Roche Ampli Chip, HaploChIP.
- NGS technology and application in Pharmacogenomics.
- Association Studies in Pharmacogenomics - Pharmacogenomics of Anticoagulation drugs.
- Ethical issues for Pharmacogenomics.
- Pharmacogenomics and Future of Pharmaceuticals.

More books for Reading and Referencing

Molecular analysis and Genome discovery; John Willey & Sons, Ltd. by Rapley, R. & Harbron, S. 2012, **ISBN: 978097758779**
Comparative genomics: empirical and analytical approaches to gene order dynamics, map alignment and the evolution of gene families; Netherlands, Kluwer Academic Publishers by Sankoff, D. & Nadeau, J.H. 2000, **ISBN:978-0-7923-6584-6, 978-94-011-4309-7**

Pharmacogenomics (4 Credits)

Syllabus	Schedule
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-	**4 days**

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.	**4 days**
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.	**5 days**
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,	**6 days**

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.	**6 days**
CIA Tests, Seminars, Presentations, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar: Pharmacogenomics (502303)

I. Objective type Questions. Choose the correct or most correct alternatives

1. Potential outcomes of pharmacogenetic research include all the following except
   - A) lower incidence of adverse drug effects.
   - B) new drug development.
   - C) higher health care costs.
   - D) improved treatment outcomes.
   - E) pretreatment screening for genetic polymorphisms.

2. The most commonly occurring variant in the human genome is
   - A) tandem-repeat polymorphism.
   - B) premature stop codon.
   - C) nucleotide base insertion.
   - D) single-nucleotide polymorphism.
   - E) defective gene splicing.

3. Genetic variations in drug targets may contribute to which drug property?

A) Bioavailability

B) Half-life

C) Racial differences in response

D) Peak-dose area under the curve

E) Entry into the central nervous system

4. CYP2D6 polymorphism can affect:

A) drug efficacy.

B) drug toxicity.

C) drug interaction potential.

D) drug delivery.

E) a, b, and c.

II. Write short notes for the following questions

5. Explain the role of Bioinformatics in Pharmacogenomics.

6. Students should complete one large sequence analysis projects during the course.

7. What is polymorphism? and explain its importance in drug targeting.

8. Prepare a Glossary for any 25 Cyp enzymes involved in Pharmacogenomics.

9. How pharmacogenomics aims to improve drug efficacy and toxicity?

10. Explain about Single Nucleotide Polymorphism and its role in Pharmacogenomics.

Program: M.Sc., Bioinformatics	Semester : III (2019-20)
Course Title: **Lab-III: Computer Aided Drug Design (CADD) (502304)**	Class Time: 10-1 :Wednesday & 2-4 :Thursday
Name of Course Teacher	Dr. Sanjeev Kumar Singh & Dr. P. Boomi

11. Describe personalized medicine and its importance.

Code: 502304 Lab-III: Computer Aided Drug Design (CADD)

Mobile: +91-9894429800	Email : skysanjeev@gmail.com

Course Brief:

The course depicts the core concepts of Computer Aided Drug Designing methods. It covers a vast range of methods and computational tools used in drug designing which includes, virtual screening methods, structure similarity searching method, protein structure prediction, molecular dynamics simulation, different types of molecular docking and its related software(s), pharmacophore concepts, combinatorial synthesis, QSAR and its theory. This course serves the students not only provides hands on experience on various computational tools but also offer sound knowledge on understanding the merits and demerits of the methods and tools available. This course also serves the students to get prepared for the extensive research in the field of Computer Aided Drug Designing.

Reference/Text Books:

Text Books:

1. Marx D and Hutter J (2012) "Ab Initio Molecular Dynamics: Basic Theory and Advanced Methods", Cambridge University Press, ISBN: 978-1107663534
2. Young DC (2009) "Computational Drug Design: A Guide for Computational and Medicinal Chemists", ISBN: 978-0470126851

Reference Books:

1. Bohm HJ (2000) "Virtual Screening for Bioactive Molecules, Volume 10", Wiley-VCH, ISBN: 978-3527301539
2. Leach, A. R. (2001) "Molecular Modeling – Principles and Applications"; Second Edition, Prentice Hall, USA, ISBN-13: 978-0582382107
3. Holtje HD (2003) "Molecular Modeling: Basic Principles and Applications", Wiley-VCH, ISBN: 978-3527305896.
4. Kubinyl H, Folkers G and martin YC (2004). "3D QSAR in Drug Design Volume 2 Ligand-Protein Interactions and Molecular Similarity", Bethany House Pub, ISBN-13: 978-0306468575.
5. Alvarez J (2005) "Virtual Screening in Drug Discovery", CRC Press, ISBN-13: 978-0824754792
6. Bannwarth W, Felder E (2008). "Combinatorial chemistry: A Practical Approach", WILEY-VCH Verlag GmbH, ISBN: 9783527301867

7. Marx D, Hutter J (2009) "*Ab Initio* Molecular Dynamics: Basic Theory and Advanced Methods", Cambridge University Press, ISBN-13: 978-0521898638
8. Anthonsen, T. (2009). "Strategies of Organic Drug Synthesis and Design. By Daniel Lednicer", Wiley-VCH, Weinheim Publisher, ISBN: 978-047019039-5
9. Young DC (2009). "Computational Drug Design: A Guide for Computational and Medicinal Chemists", Wiley-Blackwell Publishers, ISBN-13: 978-0470451847
10. Saxena A and Sahay B (2010) "Computer Aided Engineering Design", Springer; ISBN-13: 978-9048166794
11. Nag A and Dey B (2010) "Computer Aided Drug Design and Delivery systems" Mc Grahill Edition, ISBN-13: 978-0071701242
12. Yan B, zhang B (2010). "Analytical Methods in Combinatorial Chemistry, 2nd Edition". CRC Press. ISBN: 9780203909966
13. Sotriffer C (2011) "Virtual Screening: Principles, Challenges, and Practical Guidelines", Wiley-VCH, ISBN: 978-3527326365
14. Magnasco V (2013) "Elementary Molecular Quantum Mechanics", Second Edition, Elsevier, ISBN: 978-0444626479
15. Cavasatto C N (2015) "*In silico* Drug Discovery and Design – Theory, Methods, Challenges and Applications" CRC Press 1st Edition, ISBN-13: 978-1482217834.
16. Cavasotto CN (2016). "*In Silico* Drug Discovery and Design: Theory, methods, Challenges, and Applications" CRC Press, ISBN-13: 978-1482217858.
17. Grover A (2017). "Drug Design: Principles and Applications" Springer Nature Singapore Pte Ltd, ISBN-13: 978-9811051869
18. Sarkar J (2017). "Computer Aided Design: A conceptual Approach" CRC Press, ISBN-13: 978-1138885448
19. Gore M, Jagtap U B (2018). "Computational Drug Discovery and Design" Springer Protocols, ISBN: 978-1-4939-7756-7

Course Objectives: To make the students:

The main objective of this course is:

i. To provide hands on experience on various computational tools used in drug designing

ii. To make them learn about virtual screening and its types

iii. To let them understand the advantages and limitations of available molecular modeling software

iv. To learn them protein prediction methods and its validation

v. To provide them good understanding on Molecular dynamics simulation and its concepts

vi. To clear concepts of Molecular docking, pharmacophore and 3D QSAR methods

Course Outcomes: The students shall be able to

i. The students would be able to perform all the computational methods on their own
ii. They would be able to explain the concepts of molecular modeling, pharmacophore, virtual screening, molecular docking, 3D QSAR etc.,
iii. They would be well aware of the advantages and limitations of the available computational tools
iv. They would be able to analyze the problem which could arise in drug designing methods

Teaching Methods: The mode of teaching is based on the following learning activities:

- Lectures covering the theoretical part will be delivered using PowerPoint presentations.
- A set of laboratory exercises to analyze biological problems using softwares and tools to develop student's interests in scientific discovery.
- Case studies in informatics-based research.

Grading System

< 50 Marks in all	50 < Obtained Marks < 59	60 < Obtained Marks < 75	Obtained Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: The students are expected to attend the classes regularly, since regular attendance is essential to gain academic achievement. As per the University norms, the

students having a minimum scale of 70-75% attendance are only qualified to write their end-semester examinations.

Punctuality: Punctuality is the most important quality for the student to be followed and maintained to achieve success. Students who arrive late by 10 mins to the class without any vital reason will be marked absent in the attendance register. On the other hand, valid excuse including personal or medical emergency is acceptable, with prior consent by the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking practice and much more that will provide a wholesome enriched classroom experience. When students participate, they learn from one another and gain their knowledge better.

Submission of Assignment: Assignments are given to students in order to apply the concepts for deeper understanding of the subject. Therefore, each student will be allocated two assignments for the course, covering the entire topic. Students will be given deadline to submit the assignment by the course instructor and good preparation of assignment will help the students for their final exams.

Presentation of Seminar: Apart from the assignments, students are supposed to give an oral presentation during the class seminar hours in their assigned topic. The concerned instructor will encourage the participants to ask valid questions during seminar presentation in order to put up their confidence levels and communication skills. In addition, students will be able to gain information and can be updated in their course.

Preparedness: At the end of every class, the concerned instructor conveys the students about the details that will be handled in the next class to increase the student's awareness related to the topics.

Academic Dishonesty: Academic dishonesty is a completely unacceptable mode of conduct and every student should be aware of this important aspect. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Depending upon the requirement of student's possibility, the course syllabus will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairperson.

Important dates: Scheduled dates for the various activities related to the course

CIA Test I	CIA Test II	Assignment I	Seminar
As per Academic Calendar		After CIA Test -I	

Course Outline: Lab III: Computer Aided Drug Design (4 Credits)

- Energy minimization, geometry optimization, conformational analysis, global conformational minima determination; Bioactive vs. global minimum conformations
- Automated methods of conformational search; Advantages and limitations of available software; Molecular graphics;
- Computer methodologies behind molecular modeling, High throughput virtual Screening. Screening of Potential Compounds from database. Structure similarity searching. *De novo* drug designing. ADME/T for predicted ligand.
- Ramachandaran plot, Protein structure prediction software's, Protein structural visualization. Molecular dynamics simulation of native and complex protein structures. Molecular dynamics simulation of docked complex (Protein-Ligand, Protein-Protein, Protein- Metal, Protein-Nucleic acid and Protein - Substrate simulation).
- Molecular docking- different types of docking, rigid docking, flexible docking and partially rigid and partially flexible docking, manual docking Protein – ligand docking, Protein- Protein docking.
- Pharmacophore generation and analysis, pharmacophore mapping, methods of conformational search used in pharmacophore mapping
- QSAR and QSPR, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors.

More books for Reading and Referencing

Computational Drug Discovery and Design – **Riccardo Baron** Publisher: Springer Publication, 2012. ISBN: 978-1-61779-464-3
Computer-Aided Drug Design: Methods and Applications - **T. J. Perun & C. L. Propst** Publisher: CRC Press, 1989. ISBN: 978-0824780371

Lab-III: Computer Aided Drug Design (CADD) (4 Credits)

Syllabus	Schedule

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.	**3 days**
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.	**8 days**
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.	**6 days**
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	**8 days**

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	**10 days**
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance.	**5 days**

Practical, Assignment & Seminar - Lab - III Computer Aided Drug Design (CADD) (502304)

1. Energy Minimization and its application
2. Advantages and disadvantages of available molecular modeling softwares
3. *De novo* drug designing
4. Protein Structure Prediction
5. Molecular Dynamics Simulation
6. Molecular Docking and its types
7. Monte Carlo Simulations
8. Pharmacophore and Generation of Common Pharmacophore hypothesis
9. Combinatorial synthesis
10. 3D QSAR

SEMESTER-IV

Code: 502401 Machine Learning and Artificial Intelligence

Program: M.Sc.,	Semester: IV (2019-20)
Course Title and Code: **Machine Learning**	Class Time: 11-1: Monday

and Artificial Intelligence (502401)	2-5 : Tuesday
Name of the Course Teacher	Dr. RM.Vidhyavathi
Mobile: +91 - 9444835869	Email: vidhyamiss@gmail.com

Course Brief:

Machine Learning mainly focuses on the enhancement and development of the computer programs, which has the property to get changed when it comes in the interaction to the new data. However, this is a kind of artificial intelligence, the Introduction to Machine Learning course enlightens the students with the algorithms that proves to be helpful for the IP professionals in analyzing the data set with ease. In modules algorithms such as: regression, clustering, classification, and recommendation have been introduced, all these helps the candidates in supervising the advanced data programming techniques.

AI has been a source of innovative ideas and techniques in computer science, and has been widely applied to many information systems. This course provides a comprehensive, graduate-level introduction to artificial intelligence, emphasizing advanced topics such as advanced search, reasoning and decision-making under uncertainty, and machine learning.

Reference/Text Books:

Text Books:

1. Kevin Night and Elaine Rich, Nair B, (2008) “Artificial Intelligence (SIE)”, Tata Mc Graw Hill, Third Edition.
2. Ethem Alpaydin, Francis Bach, (2014) “Introduction to Machine Learning” Hardcover, Third Edition.

Reference Books:

1. Stuart Russel, Peter Norvig (2007) “AI – A Modern Approach”, Pearson Education, Second Edition.
2. Tom M. Mitchell, (2017) “Machine Learning”, McGraw-Hill Education, First Edition.
3. Ethem Alpaydin, (2004) “Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press.
4. Stephen Marsland, (2009), “Machine Learning: An Algorithmic Perspective”, CRC Press.

5. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, (2018) "Machine Learning", Pearson Education, First edition.

Course Objectives: To make the students:

The main objective of this course

i. To create appreciation and understanding of both the achievements of AI and the theory underlying those achievements.

ii. To create 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 AI programs.

iii. To introduce advanced topics of AI such as planning, Bayes networks, natural language Processing and Cognitive Computing.

iv. Machine Learning, in particular focusing on the core concepts of supervised and unsupervised learning.

v. 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.

vi. The practicals will concern the application of machine learning to a range of real-world problems

Course Outcomes: The students shall be able to

i. Demonstrate knowledge of the building blocks of AI as presented in terms Of intelligent agents.
ii. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them.
iii. Formulate and solve problems with uncertain information using Bayesian approaches.
iv. Develop an appreciation for what is involved in learning from data.
v. Understand a wide variety of learning algorithms.
vi. Understand how to apply a variety of learning algorithms to data

Teaching Methods: The mode of teaching is based on the following learning activities:

- Lectures covering the theoretical part will be delivered using PowerPoint presentations.
- A set of laboratory exercises to analyze biological problems using softwares and tools to develop student's interests in scientific discovery.

- Case studies in informatics-based research.

Grading System

< 50 Marks in all	50 < Obtained Marks < 59	60 < Obtained Marks < 75	Obtained Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
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Submission of Assignment: Assignments are given to students in order to apply the concepts for deeper understanding of the subject. Therefore, each student will be allocated two assignments for the course, covering the entire topic. Students will be given deadline to submit the assignment by the course instructor and good preparation of assignment will help the students for their final exams.

Presentation of Seminar: Apart from the assignments, students are supposed to give an oral presentation during the class seminar hours in their assigned topic. The concerned instructor will encourage the participants to ask valid questions during seminar

presentation in order to put up their confidence levels and communication skills. In addition, students will be able to gain information and can be updated in their course.

Preparedness: At the end of every class, the concerned instructor conveys the students about the details that will be handled in the next class to increase the student's awareness related to the topics.

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Subject to change clause: Depending upon the requirement of student's possibility, the course syllabus will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairperson.

Important dates: Scheduled dates for the various activities related to the course

CIA Test I	CIA Test II	Assignment I	Seminar
As per Academic Calendar		After CIA Test -I	

Course Outline: Machine Learning and Artificial Intelligence (3 Credits)

- Determine the various applications of machine learning algorithms.
- Develop an understanding classification data and models.
- Learn the how to implement the unsupervised learning algorithms, which includes deep learning, clustering, and recommendation systems.
- How to perform the supervised learning techniques, such as: linear and logistic regression.
- Understanding how to create the environment for self driving Car.
- Understanding the procedure of building the AI.
- Understanding how could a trainee provide support to the Data Scientist.
- Temporal Probabilistic Reasoning and Dynamic Bayesian Networks.

More books for Reading and Referencing

Artificial Intelligence and Machine Learning, Chandra S.S.V , Prentice Hall India Learning Private Limited, 2014, **ISBN-10:** 8120349342, **ISBN-13:** 978-8120349346.
Artificial Intelligence By Example: Develop machine intelligence from scratch using real artificial intelligence use cases , Denis Rothman, Packt Publishing Limited,2018, **ISBN-10:** 1788990544,**ISBN-13:** 978-1788990547.

Machine Learning and Artificial Intelligence (3 Credits)

Syllabus	Schedule
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.	**3 days**
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.	**8 days**
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.	**6 days**
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	**8 days**

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.	**10 days**
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance.	**5 days**

Assignment & Seminar – Machine Learning and Artificial Intelligence **(3 Credits)**

(502401)

1. Introduction to AI-Problem formulation, Problem Definition, Hill Climbing, Depth first and Breath first, Constraints satisfaction.
2. Knowledge representation using Predicate logic, Resolution, Use of predicate calculus.
3. Version Spaces and Candidate Eliminations, Decision Tree learning.
4. Feature selection, Different clustering method.
5. Sets of First Order Rules, FOCL Algorithm, Temporal Difference Learning.

Code: 502402 Systems Biology

Program: M.Sc.,	Semester : IV (2019-20)
Course Title: **Systems Biology (502402)**	Class Time: 10-1: Wednesday 2-3 : Wednesday
Name of Course Teacher	Dr. J. Joseph Sahayarayan
Mobile: +91 - 9047564087	Email jjsrbioinformatics2016@gmail.com
Name of Course Teacher	Dr. P. Boomi

Mobile: +91 - 9486031423	Email pboomi1983@gmail.com

Course Brief:

Systems biology is a broad field which explores the world of genomes and post genomic datasets and large databases. The goal of systems biology is to comprehensively understand development, physiology, metabolic and gene regulatory networks, by looking at all genes, proteins and metabolites in an organism simultaneously, rather than focusing on just one or two. An emerging engineering approach applied to biological scientific research, systems biology is a biology-based inter-disciplinary field of study that focuses on complex interactions within biological systems, using a holistic approach holism instead of the more traditional reductionism) to biological research. One of the outreaching aims of systems biology is to model and discover emergent properties, properties of cells, tissues and organisms functioning as a system whose theoretical description is only possible using techniques which fall under the remit of systems biology. These typically involve metabolic networks or cell signaling networks. Biology is moving from molecular to modular. As our knowledge of our genome and gene expression deepens and we develop lists of molecules (proteins, lipids, ions) involved in cellular processes, we need to understand how these molecules interact with each other to form modules that act as discrete functional systems. These systems underlie core subcellular processes such as signal transduction, transcription, motility and electrical excitability. In turn these processes come together to exhibit cellular behaviors such as secretion, proliferation and action potentials. What are the properties of such subcellular and cellular systems? What are the mechanisms by which emergent behaviors of systems arise? What types of experiments inform systems-level thinking? Why do we need computation and simulations to understand these systems?

Reference/Text Books:

Text Books:

1. Alberghina, L. and Westerhoff, H, (2005) "Systems Biology: Definitions and Perspectives, Topics in Current Genetics"; Springer Verlag, ISBN 978-3540229681.
2. Debmalya Barh Vasco Azevedo, (2017) "Omics Technologies and Bio-engineering"; Academic Press, Volume 1: Towards Improving Quality of Life, 1st Edition, ISBN: 9780128047491.

Reference Books:

1. Julio Collado-Vides, Ralf Hofestadt, (2002) "Gene Regulation and Metabolism: Postgenomic Computational Approaches"; MIT Press.
2. Sandy B. Primrose & Richard M. Twyman, (2004) "GENOMICS: Applications in Human Biology"; Blackwell Publishing Ltd.,
3. Andrew Carmen, Darryl León, Scott Markel, (2006) *"In Silico* Technologies in Drug Target Identification and Validation"; CRC Press Taylor and Francis Group, LLC, ISBN-13: 978-1-57444-478-0.
4. A. Malcolm Campbell & Laurie J. Heyer Laurie J. Heye, (2007) "Discovering Genomics, Proteomics and bioinformatics"; Pearson, Second Edition.
5. Marcus, Frederick, (2008) "Bioinformatics and Systems Biology"; Springer-Verlag Berlin Heidelberg, ISBN: 978-3-540-78352-7.
6. Sangdun Choi, (2010) "Introduction to Systems Biology"; Paperback Publisher: Humana Press, 1st Edition.
7. Marian Walhout Marc VidalJob Dekker, (2012) "Handbook of Systems Biology"; Academic Press, 1st Edition, ISBN: 9780123859440.
8. Lin, Ren-Jang, (2016) "RNA-Protein Complexes and Interactions Methods and Protocols"; Humana Press, 1st Edition.
9. Comai**,** Lucio, Katz, Jonathan, Mallick, Parag, (2017) "Proteomics Methods and Protocols"; Humana Press, 1st Edition.
10. Debmalya Barh, Kenneth Blum, Margaret A. Madigan, (2017) "OMICS: Biomedical Perspectives and Applications"; CRC Press, ISBN: 9781138074743.

Course Objectives: To make the students:

1. To understand how genomics applications are used to unravel the biology of life and the basic principles of systems biology.
2. To gain insight in the advantages and limitations of genomics-based experiments.
3. To appreciate the surplus value of combining data from different omics-applications as a holistic approach.
4. To provide the basis for gaining insight in bioinformatics and computational genomics.
5. The aim of the course is to provide students practical bioinformatical skills in genomics, transcriptomics, proteomics and metabolomics, knowledge of the major

web-resources and the notion about how the methods are applied in real-life scientific research.

6. The concise introductory material about aims and methods of each of the -omics is provided.
7. The explanation of how the methods are applied in science, what practical advantages and limitations they have and what challenges they help to address is provided through review and research articles.
8. The practical skills developed for using open-access databases and software tools.
9. By the end of this course students should appreciate the scientific problems involved in the post-genome evoked response audiometry biology, know where to access the immense volumes of -omics data, understand how to perform simple analysis of this data and remember examples of how the research tools are applied in published investigations.

Course Outcomes: The students shall be able to:

i. Describe the development of Omics technologies, with emphasis on genomics and proteomics.
ii. To synthesize information to discuss the key technological developments that enabled modern genomic and proteomic studies.
iii. Describe advanced genomics and proteomics technologies and the ways in which their data are stored.
iv. To use bioinformatics techniques to query examples of genomic and proteomic databases to analyze cell biology.
v. Describe the different types of genome variation and their relationship to human diseases.
vi. Discuss how biological systems information relating to the genes, proteins and cellular structures can be used to model living cells, and even to create new synthetic cells.
vii. Omics science provides global analysis tools to study entire systems.
viii. Understand the principles of integrative analysis methods for biological system analysis and interactions.
ix. Implement database search and suits for –omics.
x. Manage to analyze complex protein samples.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions.
- Case-studies and Review questions.

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, seminars, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Core: Systems Biology (3 Credits)

1. This lecture examines how the 'mega data' technologies now possible through genomics, transcriptomics and proteomics can be brought together to provide a whole organism understanding of biology.
2. This lecture will cover the basic concepts of genome sequencing, why it is important and what there is still left to learn – a basic introduction to put the remainder of the course in context.

3. The lecture will cover technologies for genome sequencing, conserved genes and proteins and the 'minimal gene content', hypothetical and unique genes and proteins.
4. This lecture will cover the use of changes in mRNA expression in different biological circumstances, including technical aspects.
5. How have the technologies learned in the above lectures been applied, particularly to the study of human disease? This lecture examines what we have gained by taking a genomics-based approach.

More books for Reading and Referencing:

Handbook of Glycomics; Editors: Richard Cummings J. Pierce; 2009 **ISBN: 9780123736000**
Essentials of Glycobiology; Editors: Ajit Varki, Richard D Cummings, Jeffrey D Esko, Hudson H Freeze, Pamela Stanley, Carolyn R Bertozzi, Gerald W Hart, and Marilynn E Etzler; 2009, **ISBN: 13: 9780879697709**
Evolutionary Genomics and Systems Biology; Gustavo Caetano-Anollés; 2010 **ISBN: 978-0-470-19514-7**
Principles of Biochemistry; By David L. Nelson, Michael M. Cox; 2012 **ISBN: 9788808035868**

Systems Biology (3 Credits)

Syllabus	Schedule
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.	**14 days**
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.	**12 days**
Unit III: Protein complexes and Networks: Protein binding site analysis,	**10 days**

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.	**16 days**
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.	**16 days**
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance.	**5 days**

Assignment & Seminar: Systems Biology (3 Credits)(502402)

1. Techniques in proteomics.
2. Gene expression.
3. 2D Gel electrophoresis and protein array.
4. Mass Spectrometry.
5. Protein sequences.
6. qRT PCR and proteomics.
7. MALDI TOP MS, QTrap MS/MS.
8. Identification and measurement of all small molecules.
9. Glycomics.
10. Lipidomics.
11. Flucomics.
12. Biomics.
13. E-CELL, V-CELL and GROMOS.

Code: 502403 Lab-IV Small and Macromolecular Crystallography

Program: M.Sc.,	Semester: IV (2019-20)
Course Title and Code: **Lab IV-Small and Macromolecular Crystallography** (502403)	Class Time: 4-5: Wednesday 10-1: Thursday
Name of the Course Teacher	Prof. J. Jeyakanthan
Mobile: +91 - 97898 09245	Email: jjkanthan@gmail.com

Course Brief:

X-ray crystallography is the only available technique that enables us to visualize protein structures at the atomic level and enhances our understanding of protein function. Specifically we can study how proteins interact with other molecules, how they undergo conformational changes, and how they perform catalysis in the case of enzymes. Armed with this information we can design novel drugs that target a particular protein, or rationally engineer an enzyme for a specific industrial process. This syllabus is framed on the basis that the students will have a technical knowledge in handling the small and macromolecules techniques such as - crystallization, diffraction, data collection and structure solution.

References/ Text Books:

Text Books:

1. Marcus Frederick Charles Ladd and Rex Alfred Palmer, (2003), Structure Determination by X-ray Crystallography, Springer.
2. Giacovazzo, C. Monaco, H.L. Artioli, G. Viterbo, D. Milanesio, M. Ferraris, G. Gilli, G. Gilli, P. Zanotti, G. Catti, M. (2011) “Fundamentals of Crystallography - Third Edition”; International Unioin of Crystallography; Oxford [u.a.]: Oxford Univ. Press, Oxford Science Publications.
3. Gale Rhodes (1999). "Crystallography Made Crystal Clear: A Guide for users of Macromolecular Models - Second Edition"; Academic Press.
4. George H. Stout and Lyle H. Jensen (1989). "X-ray Structure Determination - Second Edition"; John Wiley & Sons - A wiley-interscience Publication.
5. Christopher Hammond (2009). "The Basics of Crystallography and Diffraction - Third Edition"; International Unioin of Crystallography, Oxford University Press.
6. Car melo Giacovazzo (2014). "Phasing in Crystallography - A Modern Perspective"; Oxford University Press.

Reference Books:

1. Banaszak, L. J.(2000) “Foundations of Structural Biology”; Academic Press

2. Bourne, P.E. & Helge Weissig, H. (2003) “Structural bioinformatics”; Wiley-Liss.
3. Liljas, A., Liljas, L., Piskur, J., Lindblom, G. Nissen, P. Kjeldgaard, M. (2010) “Textbook of Structural Biology”; Hackensack, NJ: World Scientific.

Course 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.

Course Outcomes: The students shall be able to

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.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Having an enriched professional experience on handling associated molecular biology experiments (Isolation, cloning, expression and crystallization) with sophisticates equipments and accessories
- Handling advanced Polarized microscopes to view crystallized biomolecules with better fine resolution to proceed further accordingly.
- Case-studies and Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, seminars, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance has been taken will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class/Lab Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Performing Lab Practicals: The basic techniques concerning subjects such as Molecular or Cell biology are taught with much clarity and every student is given the opportunity to have hands on experience with these techniques using sophisticated instruments under the supervision of experienced/ trained personnel. After training, lab practicals are conducted to assess the student's skills to handle equipments and performing experiments with ease and maintaining the time constraints.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test I	

Course Outline: Lab-IV: Small and Macromolecular Crystallography (4 Credits)

- The course will lead to determine the crystal structures of small and macro molecules.
- On completion of this course students will be able to describe the differences in properties of small and macro molecular crystals.
- The Course content includes - X-ray sources and types of detectors, diffraction experiment based on the Evald construction, process diffraction images, and data validation. Phase problem solving, protein model construction based on experimental electron density maps and choose proper algorithms for structure refinement. Usage of specific crystallographic software for structure visualization and refinement and Validate the final structures.

More books for Reading and Referencing

Introduction to Macromolecular Crystallography by Alexander McPherson; 2009, **ISBN:978-0-470-18590-2**
Macromolecular Crystallography Protocols, Volume 2 Structure Determination; Editors: Doublie, Sylvie (Ed.); 2007, **ISBN:1-59745-266-1, 978-1-58829-902-4**
Principles of Protein X-Ray Crystallography; Authors: Drenth, Jan, 1999, **ISBN:978-1-4757-3094-4, 978-1-4757-3092-0**
Small Angle X-Ray and Neutron Scattering from Solutions of Biological Macromolecules by Dmitri I. Svergun, Michel H. J. Koch, Peter A. Timmins, Roland P. May, 2013, **ISBN:978-0-19-963953-3**

Lab-IV: Small and Macromolecular Crystallography (4 Credits)

Syllabus	Schedule
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.	**5 days**
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.	**10 days**
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.	**6 days**
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.	**4 days**
CIA Tests, Seminars, Presentations, Reviews, Assignments, Journal club and Career Guidance.	**5 days**

Practical, Assignment & Seminar Lab-IV Small and Macromolecular Crystallography (502403)

1. Small molecule crystallization methods.

2. X-ray diffraction data collection, structure determination, structure refinement and Validation of small molecules.
3. Small molecular compounds isolated from plants or from marine source.
4. Cloning, Expression, Purification of Proteins, Carbohydrates, Nucleic acids.
5. Crystallization methods of macromolecule (Hanging drops, Sitting drops and Micro batch methods etc.,)
6. Macromolecular structure determination methods (MR/ SIR/ MIR/ SAD/ MAD).
7. Structure refinement, structural analysis and Validation of macromolecules.
8. WinGX platform for small molecule structure determination.

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.

Teaching Methods:

- Literature review, analysis and data collection
- Case-studies and Review questions
- Allowed for interaction with Research scholars
- Daily guidance and monitoring the work flow

- Presentation

Grading System

< 50 Marks in all	50 < Marks < 59	60 < Marks < 75	Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on the target work, presentation, observation and results. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks	**End-Semester Exam: 75 Marks**		
Project work regular update for 25 Marks	**Dissertation**		
	Internal	**External**	**Viva**
	25	50	25

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

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Major Electives

Code: 502501 General Chemistry

Program: M.Sc., Bioinformatics	**Semester :** I (2019-20)
Course Title: Elective –I General Chemistry (502501)	**Class Time:** 12-1: Monday 3-4 : Tuesday 12-1: Wednesday 2-4 : Thursday
Name of Course Teacher:	Dr. P. Boomi
Mobile: +91-9486031423	**Email :** pboomi1983@gmail.com

Course Brief:

Chemistry is a branch of science that deals with the study of the composition, properties, and reactivity of matter that includes organic chemistry, in-organic chemistry, physical chemistry etc. In bioinformatics, chemistry has a pivotal role to systematic investigation of the properties, structure, behavior of matter and the changes matter undergoes. The student will need to improve the basic aspects of chemistry and it will expose to develop in related disciplines like interaction between the chemical compounds and the bio-molecules. Hence, the syllabus is framed to provide sound knowledge and understanding of chemistry to divulge biological and biomedical science. The purpose of this syllabus is to develop scientific temper and analytical capability through learning physical concepts and their applications in pharmaceutical. This syllabus for the course covers with organic chemistry, inorganic chemistry, nano-chemistry, bio-organic chemistry, bio-inorganic chemistry and important analytical techniques to gain an insight into the basics of knowledge of chemistry. This course highlights the information regarding synthesis of drug compound using organic and in-organic materials for drug discovery, therapy, imaging and diagnosis. It will also guide the students to understand how chemistry will be used for a high technology area of Bioinformatics.

Reference/Text Books:

Text Books:

1. V. R. Gowariker, N.V. Viswanathan and N.V. Jayadev Sreedhar, (2008) "Polymer Science", Publishers-New Age International Pvt. Ltd. 1st Edition.
2. R. Gopalan, (2009) "Inorganic Chemistry", Universities Press.
3. R. Cammack, (1999) "Iron-Sulfur Proteins" Academic Press

Reference Books:

1. R.V. Eldik, (2004) "Advances in Inorganic Chemistry" Vol-55, Publisher-Elsevier.
2. S. Ahuja, and Jespersen, N. (2006) "Modern Instrumental Analysis", Vol-47, Elsevier.
3. J.P. Agrawal and R.D. Hodgson, (2007) "Organic Chemistry of Explosives" John Wiley & Sons Ltd.
4. J. McMurry, (2008), "Organic Chemistry", 7th Edition, Thomson Higher Education.
5. C. Brechignac, P. Houdy and M. Lahmani, (2008) "Nanomaterials and Nanochemistry", Springer Science & Business Media.

6. A. Lewis, (2009) "Drug-Device Combination Products: Delivery Technologies and Applications" Elsevier, Woodhead Publishing series in Biomaterials
7. D. Thassu, M. Deleers, Y. Pathak (2007) "Nanoparticulate Drug Delivery Systems" Edition-Informa Healthcare USA, Inc.
8. S. Atul, (2010) "The Pearson Guide to Objective Chemistry for the AIEEE", Pearson Education India.
9. D.G. Watson, (2011) "Pharmaceutical Chemistry E-Book", Publisher-Elsevier Health Sciences.
10. M.K. Bhattacharjee, (2016) "Chemistry of Antibiotics and Related Drugs" Publisher-Springer
11. J. E. House, (2012) "Inorganic Chemistry", 2nd Edition, Publisher-Academic Press.
12. J. Clayden, N. Greeves, and S. Warren, (2012) "Organic Chemistry", OUP Oxford, 2nd Edition.
13. W. Kaim, B. Schwederski and A. Klein, (2013) "Bioinorganic Chemistry-Inorganic Elements in the Chemistry of Life: An Introduction and Guide", John Wiley & Sons, 2nd Edition.

Course Objectives: To make the students:

i. To learn about basic idea of aomaticity, organic synthesis, aliphatic nucleophilic substitution reactions, aromatic nucleophilic and electrophilic substitution reactions.

ii. To understand the fundamental concepts of structure, reactivity and acid base theory.

iii. To explain the general information about nano chemistry, polymer chemistry and pharmaceutical chemistry with their uses.

iv. To understand the biological molecule present in the bio-organic and bio-inorganic compounds.

v. To define the heme protein, non heme protein and electron transfer proteins.

Course Outcomes: The students shall be able to:

i. The course aims in gaining an understanding the reaction mechanism of substitution reaction and how to synthesis the organic compounds by chemical method.
ii. Students will gain the concept of bonding theory and acid base theory with their hardness and softness.
iii. Students will learn the different types of polymer, variety of antibiotics and

pharmaceutical polymers.
iv. Student can make the knowledge of the relationship between bioinorganic and bioorganic chemistry
v. Be able to get innovative idea for mini project work

Teaching method:

There are a number of different teaching methods used such as:

- Lecture using power point presentation
- Discussion (Boards and Blogs)
- Case studies
- Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 60	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour tests for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance has been taken will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking

process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Elective: General chemistry (502501) (5 Credits)

- **Organic chemistry:** can be describing the aromatic substances that involve the study of carbon and its compounds**.** It includes aromaticity, synthesis of organic compound and heterocyclic compound.

- **Nucleophiles and Electrophiles:** It includes aliphatic substitution and elimination reactions. It can be study donate and accept the pair of electron.
- **Chemical bonding:** It is one of the most important basic fundamentals of chemistry that explains how compounds form based on the electrostatic interaction and other concepts such as various bonding theory and also explain the relationship between acid and base theory.
- **Nano Chemistry:** It is an emerging field that involves study of unique properties associated with assemblies of atoms or molecules of nanoscale, the types of nano structures such as one, two and three dimensional. **Polymer chemistry and pharmaceutical chemistry** include classification of polymer with their uses and applications.
- **Bio-organic chemistry:** it deals with study of different types, structures and functions of biological molecules that include fats, steroids, coenzyme A, thiamine NAD+, NADP+, FMN, FAD, lipoic acid and Vitamin B_{12}.
- **Bio-inorganic chemistry:** It examines the role of metals in biology**,** which covers the metalloprotein like hemoglobin and myoglobin, Electron transfer proteins: Active site structure and functions of ferredoxin, rubridoxin and cytochromes.
- **Characterization Techniques:** Basic principle, theory and different analytical techniques like UV-Vis, FT-IR, NMR, mass spectroscopy, XRD, TG/DTA & DSC, SEM and TEM.

More books for Reading and Referencing

Amit Arora, "Organic Chemistry: Aromatic, Alcohols Aldehydes & Acids", (2006), Publisher- Discovery Publishing House, (**ISBN:8183561896, 9788183561891**)
John A. Joule and Keith Mills, "Heterocyclic Chemistry", (2013), Publisher- John Wiley & Sons, (**ISBN: 1118681649, 9781118681640**)
Marye Anne Fox, James K. Whitesell, "Organic chemistry", (2004), Publisher-Jones & Bartlett Learning, (**ISBN: 763721972, 9780763721978**)
Paul M. Dewick, "Essentials of Organic Chemistry: For Students of Pharmacy, Medicinal Chemistry and Biological Chemistry", (2006), Publisher-John Wiley & Sons, (**ISBN: 0470016655, 9780470016657**)
J. Newton Friend, "A text book of in-organic chemistry" (2012), Publisher-Hardpress, (**ISBN: 290327793, 9781290327794**)
I. David Brown, "The Chemical Bond in Inorganic Chemistry" (2006), Publisher-Oxford University Press, (**ISBN: 0199298815, 9780199298815**)

John C. Kotz, Paul M. Treichel and John Townsend, "Chemistry and Chemical Reactivity", (2014), 9th Edition, Publisher- Cengage Learning, (**ISBN:1305176464, 9781305176461**)
Geoffrey A. Ozin, and Andre C. Arsenault, (Nanochemistry: A Chemical Approach to Nanomaterials", (2015), Publisher- Royal Society of Chemistry, (**ISBN:1782626263, 9781782626268**)
Kenneth J. Klabunde, and Gleb B. Sergeev "Nanochemistry " (2013) 2nd Edition, Publisher- Newnes, (**ISBN: 0444594094, 9780444594099**)
A. Ravve, " Principles of Polymer Chemistry", (2013), Pubisher- Springer Science & Business Media, (**ISBN: 1489912835, 9781489912831**)
Gauri Shankar Misra, "Introductory Polymer Chemistry", (1993), (**ISBN: 8122404715, 9788122404715**)
S. M. Khopkar, "Basic Concepts Of Analytical Chemistry", (1998), Publisher-New Age International, (**ISBN: 8122411592, 9788122411591**)
John Kenkel, "Analytical Chemistry for Technicians, Fourth Edition", (2013), Publisher-CRC Press, (**ISBN: 1439881065, 9781439881064**)
David Van Vranken and Gregory Weiss, "Introduction to Bioorganic Chemistry and Chemical Biology", (2012), Publisher- Garland Science, (**ISBN: 1135054827, 9781135054823**)
K. Hussain Reddy "Bioinorganic Chemistry", (2007), Publisher-New Age International, (**ISBN: 8122414370, 9788122414370**)
Ivano Bertini, "Biological Inorganic Chemistry: Structure and Reactivity", (2007), Publisher-University Science Books, (**ISBN: 1891389432, 9781891389436**)

General chemistry

Syllabus	Schedule
Unit-I **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.	**10 days**

Unit-II **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.	**12 days**
Unit-III **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.	**13 days**
Unit-IV **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.	**10 days**
Unit-V **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	**18 days**

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	
CIA Tests, Seminars, Presentations, Reviews, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar – General Chemistry (502501)

1. Write a brief note on aromaticity and anti-aromaticity.
2. Explain the detail about annulenes and fulvenes.
3. How to synthesis of primary and secondary alcohol.
4. Define the structure and application of pyrrole, and imidazole.
5. Give a detailed account on SN_1 and SN_2 reaction and mechanism.
6. Discus the Bimolecular reaction and mechanism.
7. Define neighboring group participation and leaving group
8. Describe the Vander-Waals forces and Molecular orbital theory.
9. Types of chemical bonding.
10. Structure and uses of polymethacrylate, polyvinyl alcohol

Code: 502502 Fundamentals of Computing

Program: M.Sc.,	Semester: I (2019-20)
Course Title and Code: **Fundamentals of Computing (Elective-I) (502502)**	Class Time: Candidates select the course
Name of the Course Teacher	-
Mobile: -	Email: -

Course Brief:

Computer technology's has impacts on individuals and our world. It helps to access worldwide sources of information; presenting ideas orally, graphically and in writing. This course examines the interaction between information and methods of communication technology. It explores the impact that technology has on individuals and organizations and the effects of current technology infrastructure plus use, duplication and transmission of information in our world. The course links technology with communication to provide

students with access to a wealth of data and information, both locally and globally. The fundamental of computing is designed to familiarize students with computers and their applications. It will help students to learn fundamental concepts of computer hardware and software and become familiar with a variety of computer applications. Students will investigate internet based application and also includes activities that explore social and ethical issues related to computers. Students will exhibit proficiency with software applications and demonstrate knowledge of computer technology and components to aide in their understanding of data and information. After learning this course, it helps students in the development of applications related to data-analytical and theoretical methods, mathematical modeling and computational simulation techniques to study of biological, behavioral and social system. It also help biology student to learn the complicated biological systems and to organize, share or visualize the vast amount of biological data.

Reference/Text Books:

Text Books:

1. V. Rajaraman, Neeharika Adabala (2014) "Fundamentals of Computers"; PHI learning Private limited, New Delhi, Sixth Edition.
2. ITL Education Solutions Limited, 2011, "Introduction to Computers", Pearson Education India, Second Edition.

Reference Books:

1. Andrew S. Tanenbaum, David J. Wetherall. (2012) "Computer Network"; Pearson Educations.
2. Danny Briere, Walter R. Bruce, (2011)," Wireless Home Networking For Dummies", John Wiley & Sons, Third Edition.
3. John R. Levine, (2010),"The Internet For Dummies", John Wiley & Sons Twelfth Edition.
4. John, R., Levine, Young, M.L and Baroudi, C. (2007) "The Internet for Dummies", Willy Publishing Inc, Eleventh Edition.
5. Jan Vitek, Christian D. Jense, (2007)," Secure Internet Programming", Springer.
6. R.G. Dromey, (2007), "How to Solve it by Computer", Pearson Education, Fourth Reprint.
7. Chris McNab, (2007)," Network Security Assessment ", O'Reilly Media, Second Edition.
8. D.A. Godse A. P.Godse, (2006),"Computer Organization and Architecture"

Technical Publications

1. Curtis Frye, (2003) Step by Step Microsoft Excel 2003, Microsoft Press.
2. Leon, A., Leon, M. (2000) "Introduction to Computers"; Vikas Publishing House.

Course Objectives: To make the students:

i. Identify types of computers, how they process information and how individual computers interact with other computing systems and devices.
ii. Identify the function of computer hardware components
iii. Identify how to maintain computer equipment and solve common problems relating to computer hardware
iv. Identify how software and hardware work together to perform computing tasks and how software is developed and upgraded
v. Manipulate and control the Windows desktop, files and disks
vi. Identify network fundamentals and the benefits and risks of network computing
vii. Identify the relationship between computer networks, other communications networks (like the telephone network) and the Internet
viii. Identify different types of information sources on the Internet

Course Outcomes: The students shall be able to

i.	To understand the basics of computer system, its architecture, database and networks.
ii.	To understand the basic concepts, terminology of computer science and familiar with the use of IT tools.
iii.	To learn and explore new IT techniques in various applications and to identify the issues related to security.
iv.	To learn the working knowledge of hardware and software of computer.
v.	To learn the use of database such as Microsoft access predictive modelling, and identifying new trends and behaviour's.
vi.	To learn the various features of MS-office.
vii.	Create, send and receive email.

viii.	Perform basic word processing functions.
ix.	Demonstrate basic file management techniques.
x.	Use CCRI online tools.
xi.	To familiarize the students with the network devices and the internet.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Case-studies and Review questions

Grading System

< 50 Marks in all	50 < Marks < 59	60 < Marks < 75	Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two,3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance has been taken will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking

process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Elective-I: Fundamentals of computing (502502)

- On completion of the course the students will be able to understand the fundamentals of computer and its organization.
- It will also allow student to concentrate on computer networking and data security.
- Also gives knowledge to the student about internet and its applications.

More books for Reading and Referencing

Fundamentals Of Computer Algorithms - 1998 Horowitz, Galgotia Publications and **(ISBN: 8175152575, 9788175152571)**
Fundamentals of Computing and Programing – 2008 A.P.Godse, D.A.Godse, Technical Publications and **(ISBN: 8184315090, 9788184315097)**
Computer Fundamentals – 2004 Larry Long, Dreamtech Press and **(ISBN : 8177223674, 9788177223675)**

Fundamentals of Computing

Syllabus	Schedule
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	**6 days**
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	**8 days**

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).	**10 days**
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.	**12 days**
Unit-V **Internet:** The Internet and its Resources, Internet protocols, services, and related terminologies. Web browsers, customizing browsers, Blocking popup windows, Internet programming languages.	**5 days**
CIA Tests, Seminars, Presentations, Reviews, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar - Fundamentals of computing (502502)

1. Describe the organization of computer
2. Brief about software and its applications
3. Explain computer networking and data communication in detail
4. An overview of computer viruses.
5. Internet and its resources.
6. Encryption/Decryptions techniques
7. Internet protocols
8. OSI Reference Model
9. Types of modern computers
10. Different types of web browsers

Code: 502503 IPR, Bio-safety and Bioethics

Program: M.Sc., Bioinformatics	**Semester :** I (2019-20)
Course Title: IPR, Biosafety and Bioethics (502501)	**Class Time:** Candidates select this course
Name of Course Teacher	
Mobile**:**	Email :

Course Brief:

The course introduces students to Intellectual Property (IP) Law in general and its two common categories: Industrial Property (mostly patents) and Copyright. Intellectual Property is undoubtedly perceived as one of the core fields in the emerging area of law, the need specialized professionals. The course provides an overview of the main principles and legal rules of IP Law, focusing specifically on the theoretical connections between IP and academic/scientific works/studies and on the IP issues with which the students are likely to come into contact in their different areas of knowledge. The course on Intellectual Property Rights, Biosafety and Bioethics covers all aspects of creations of the intellect (Images, inventions, literary works, artistic works etc.), Patent application, rules essential for patents, genetically modified crops and plants with their impacts, general ethical issues in handling transgenic plants, animals and microorganisms at laboratory etc. It also deals with new and upcoming areas like ethical issues associated with embryonic stem cells, genetic testing and regulatory approval to conduct human clinical trials. This course has been designed to give the students a holistic understanding of the subject. The concept of IP, its creation and how it should be protected are the major key points which will be discussed during this course.

Reference/Text Books:

Text Books:

1. Recombinant DNA safety guidelines, (1990), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
2. Deepa Goel; Shomini Parashar, (2015) IPR, Biosafety and Bioethics, Pearson India, ISBN: 9789332514249.

Reference Books:

1. Revised guidelines for research in transgenic plants, (1998), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
2. Subbaram, N. (2007) "Patent Law Practices and Procedures" Pharma Book Syndicate, Hyderabad, 2nd Edition.

3. **M. K. Sateesh,** (2008) Bioethics and Biosafety, K. International Pvt Ltd.
4. Robert Dingwall, (2008) Cambridge textbook of bioethics, Cambridge University Press, Cambridge, ISBN -13: 978-0-521-69443-8.
5. Glick, B.R., and Pasternack, J.J. (2010) "Molecular Biotechnology"; ASM Press, Washington, DC, 4th Edition.
6. Chawla, H.S. (2011) "Introduction to Plant Biotechnology"; Oxford & IBH Publishing Co. Pvt. Ltd. 3rd Edition.
7. Shomini Parashar, Deepa Goel, (2013) IPR, Biosafety and Bioethics, Pearson India, ISBN: 9788131774700.

Course Objectives: To make the students:

Students will be able to

i. Get a holistic understanding of the complexities involved in the process of featuring intellectual property rights to people.

ii. Learn the legalities of intellectual property to avoid plagiarism and other IPR relates crimes like copyright infringements, etc.

iii. Understand the protection of academic/scientific works/studies by intellectual property rights.

iv. Learn about the legal, safety and public policy issues raised due to the rapid progress in Biotechnology and development of new products

Course Outcomes: The learning outcomes shall make the students to:

i.	Understand the principles, function and basic legal rules of IP Law.
ii.	Recognize the relevant criteria for generating and protecting intellectual works.
iii.	Understand the relevance and impact of IP Law on academic/scientific works/studies.
iv.	Recognize the intellectual property likely to be produced in the academic and professional environment.
v.	Understand the different forms of violation of intellectual property rights.
vi.	It is expected that students will be more confidant to practice and implement all these policies in their future endeavor.

Teaching Methods: The mode of teaching is based on the following learning activities:

- Lectures covering the theoretical part will be delivered using PowerPoint presentations.
- A new set of problems and issues that are worthy of exploration related to this course will be conversed.
- Case studies and questions.

Grading System

< 50 Marks in all	50 < Obtained Marks < 59	60 < Obtained Marks < 75	Obtained Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, seminars, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and is converted to 15 marks	Assignments, Reviews, and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: The students are expected to attend the classes regularly, since regular attendance is essential to gain academic achievement. As per the University norms, the students having a minimum scale of 70-75% attendance are only qualified to write their end-semester examinations.

Punctuality: Punctuality is the most important quality for the student to be followed and maintained to achieve success. Students who arrive late by 10 mins to the class without any vital reason will be marked absent in the attendance register. On the other hand, valid excuse including personal or medical emergency is acceptable, with prior consent by the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking practice and much more that will provide a wholesome enriched classroom experience. When students participate, they learn from one another and gain their knowledge better.

Submission of Assignment: Assignments are given to students in order to apply the concepts for deeper understanding of the subject. Therefore, each student will be allocated two assignments for the course, covering the entire topic. Students will be given deadline to submit the assignment by the course instructor and good preparation of assignment will help the students for their final exams.

Presentation of Seminar: Apart from the assignments, students are supposed to give an oral presentation during the class seminar hours in their assigned topic. The concerned instructor will encourage the participants to ask valid questions during seminar presentation in order to put up their confidence levels and communication skills. In addition, students will be able to gain information and can be updated in their course.

Preparedness: At the end of every class, the concerned instructor conveys the students about the details that will be handled in the next class to increase the student's awareness related to the topics.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Depending upon the requirement of student's possibility, the course syllabus will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Scheduled dates for the various activities related to the course

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test I	

Course Outline: Elective: IPR, Bio-safety and Bioethics (502503)

- An outline of Intellectual property rights- World Trade Organisation (WTO) -WTO Agreements- General Agreement on Tariffs and Trade (GATT) - General Provisions and Basic Principles-Protection of different types of plant variety.
- Types of Intellectual property rights-TRIPs -Trademarks and copyrights-act and law.
- Procedures for GMOs intended for direct use-risk assessment-risk management-handling, transport, packaging and identification of GMOs.

- Patenting and the Procedures Involved in the Application for Grading of a Patent - Steps to a Patent - Compulsory Licenses - Patent Cooperation Treaty (PCT)-Some case studies-Beneficial role of Transgenic plants and animals.
- Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cell.
- An Overview of the Legal and Socio-economic Impacts of Biotechnology - Biosafety Regulations-Good laboratory practices-Different types of containment.
- Bioethics introduction-Various ethical issues related to genetic studies, human genome project-stem cell applications and ethical issues in stem cell research-cloning- instrumentality.

More books for Reading and Referencing

An Introduction to Intellectual Property Rights-**Manju Pathak** Publisher: New India Publishing Agency, 2013. **(ISBN: 978-93-833-0512-4)**
Intellectual Property Rights- **Neeraj Pandey, Khushdeep Dharni** Publisher: PHI Learning Pvt. Ltd-New Delhi, 2014. **(ISBN: 978-81-203-4989-6)**
WIPO Intellectual Property Handbook- **Wipo Publication** Publisher: WIPO 2004, Second Edition. **(ISBN: 978-92-805-1291-5)**
Bioethics and Biosafety**- M. K. Sateesh** Publisher: I. K. International Pvt Ltd, 2008. **(ISBN: 978-81-906-7570-3)**
Bioethics and Biosafety in Biotechnology-**V. Sree Krishnan** Publisher: New Age International (P) Limited, New Delhi, 2007. **(ISBN: 978-81-224-2248-1)**
IPR, Biosafety and Bioethics- **Deepa Goel, Shomini Parashar** Publisher: Pearson Publication, First edition, 2013. **(ISBN: 978-93-325-1424-9)**
Patent law - **P Narayanan** Publisher: Eastern Law House; 3rd edition, 1998. **(ISBN: 978-81-717-7090-8)**
Introduction to Bioethics- John A. Bryant, Linda Baggott la Velle, John F. Searle Publisher: Wiley publications, 2005. **(ISBN: 978-0-470-02198-9)**

Elective: IPR, Bio-safety and Bioethics

Syllabus	Schedule

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.	**14 days**
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.	**10 days**
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.	**8 days**
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.	**10 days**
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.	**8 days**
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance.	**5 days**

Assignment & Seminar Elective: IPR, Bio-safety and Bioethics (502503)

1. Establishment and functions of GATT, WTO and WIPO.
2. Explain transgenic plants and its beneficiary role.
3. Write short notes on Biosafety and its different levels.
4. Derive the government patent rules.
5. Give an account on FLAVA SAVR^{tm} turmeric as model case.
6. Explain WTO summit and WTO agreements.
7. Write a short note on environmental impact of genetically modified plants.
8. Explain the ethical issues related to research in embryonic stem cell cloning.
9. Impact of GM crops in agriculture.
10. Discuss about GATT's principle of reciprocal tariff liberalization.

Code: 502504 Biosensor

Program: M.Sc.,	Semester : III (2019-20)
Course Title: **Biosensor** (502504)	Class Time: Candidates are selecting the course
Name of Course Teacher:	-
Mobile: -	Email : -

Course Brief:

Biosensor comprises a hybrid course that integrates a natural bio-recognition element like cell, enzyme, antibody etc. Biosensors are emerging analytical tools for the analysis of bio-material samples to gain an understanding of their bio-composition, structure and function by converting a biological response into an electrical signal. This course can be providing diverse applications like medicine, biomedical research, drug discovery, diabetes, environmental monitoring, security and military. The syllabus is focused on sensor, biosensor, nanomaterials based biosensor, medical biosensor and enzyme based biosensor. This course is also providing in the general principles of sampling analysis, statistical presentation and manipulation of data. It provides the basic

science concepts required to understand the design and application of biosensors for the students. It is expected that students will get ample scope to learn and update knowledge through their active students in the lectures, discussions or demonstrations and suitable hands-on experiments. Also assignments and case studies will be conducted to stimulate research motivation of the students.

Reference /Text Book:

Text Books:

1. D.G. Buerk, (1995) "Biosensor:Theory and Apllication", Publisher-CRC press.
2. M. Alexander, B.R. Bloom, D.A. Hopwood, R. Hull, etc., (2000) "Encyclopedia of Microbiology", Vol-IV, Publisher-Academic Press.

Reference Books:

1. Blum, "Biosensor Principles and Applications", Vol-15, CRC Press, (1991).
2. J. Vetelino, and A.Reghu, (2010) "Introduction to Sensors", Publisher-CRC Press.
3. A. Mulchandani and K. Rogers, (2010) "Enzyme and Microbial Biosensors: Techniques and Protocols", Publisher-Humana Press.
4. S. Higson, (2012) "Biosensors for Medical Applications", Publisher-Elsevier.
5. J. Li, N. Wu, (2013) "Biosensors Based on Nanomaterials and Nanodevices", Publisher-CRC press.
6. M. Bock Gu, H-S. Kim, (2014) "Biosensors Based on Aptamers and Enzymes", Springer.

Course Objectives: To make the students:

i. Exposing students to the fundamentals of basic biosensor with their principles and technologies.

ii. Preparing students to build a career in bio-inspired materials and devices.

iii. Making aware of latest principles and techniques of nanomaterials based biosensor, medical biosensor and enzyme biosensor

iv. Enriching scientific temper in the field of bio-sensing, bio-imaging for clinical applications.

v. Updating students with the advanced techniques and totally integrated various biosensors.

vi. Orienting students towards research and development activities on bio-compatibility, bio-specificity, bio-functionality and toxicology aspects of nano material based biosensors.

Course Outcomes: The students are to be able to:

i. Be able to know how to use bio-molecules as biosensor.
ii. Be able to analyze what types of material are used for biomedical applications.
iii. Be able to use multivariate data analysis.
iv. Be able to design a biosensor system for a specific analyte.
v. Be able to understand the importance of biosensors in the medical and environmental fields.
vi. Be able to estimate the future economical potential of biomedical sensors.
vii. Be able to realize how to use biosensor in future health care system.

Teaching method will be based on the following activities:

- Lecture using power point
- Discussion (Boards and Blogs)
- Case studies
- Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on internal and external exams, assignments, seminars, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour tests for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Attendance and participation are vital to the student's success in this course. Students are expected to attend class every day. Minimum attendance to be eligible to take end-semester-examination is 80%. It is also essential that the students study regularly.

Punctuality: Punctuality is very important in the course, because if student are late, you not only waste your time, but other student's. You will also disturb others when you go into the

lecture class or laboratory after the class begins. Therefore, please arrive at the class on time. Names of late students will be recorded by mentor and marks from Course performance will be deducted. An excuse for being absent from class shall be a medical or personal emergency acceptable at the discretion of the Head of the Dept.

Class Participation: Class participation and interaction helps to form a complete educational experience. However, class participation and interaction is to be relevant to course content and context. Deviant behavior may lead to dismissal or suspension.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar

As per Academic Calendar	After CIA Test-I

Course Outline: Biosensor (502504)

- The course is to give a general overview of basic aspects and classification of **sensor** and **biosensor.**
- **Nanomaterials based Biosensor:** Nanomaterials fabrication can be utilized to manufacture nano-biosensors, which have very high sensitivity and can be applied in biomedical diagnostic.
- **Medical biosensor:** it covers the biosensors for medical oriented applications and types of medical biosensors.
- **Enzyme based biosensor:** it can be used to study, how to apply the variety of enzyme as biosensor and also study the glucose monitoring in blood sample.

More books for Reading and Referencing

Donald G. Buerk, "Biosensors: Theory and Applications", (1995), Publisher-CRC Press, **ISBN: 0877629757, 9780877629757**
Xueji Zhang, Huangxian Ju and Joseph Wang, "Electrochemical Sensors, Biosensors and their Biomedical Applications" (2011), Publisher- Academic Press, **ISBN: 008055489X, 9780080554891**
Jon S. Wilson, "Sensor Technology Handbook", (2005), Publisher-Newnes, **ISBN: 0750677295, 9780750677295**
Alexandru Grumezescu, "Nanobiosensors", (2016), Publisher- Academic Press, **ISBN: 0128043725, 9780128043721**
Zoraida P. Aguilar,"Nanomaterials for Medical Applications", (2012), Publisher-Newnes, **ISBN: 0123850894, 9780123850898**
Seamus Higson, "Biosensors for Medical Applications", (2012), Publisher-Elsevier, **ISBN: 0857097180, 9780857097187**
Ursula E. Spichiger-Keller, "Chemical Sensors and Biosensors for Medical and Biological Applications" (2008), Publisher- John Wiley & Sons, **ISBN: 3527612262, 9783527612260**
Man Bock Gu, Sung Kim-Hak, "Biosensors Based on Aptamers and Enzymes", (2014), Publisher-Springer, **ISBN: 3642541437, 9783642541438**
Zhiwei Zhao, Helong Jiang, "Enzyme-based Electrochemical Biosensors", (2010),

Publisher-INTECH Open Access, **ISBN: 9537619990, 9789537619992**

Biosensor

Syllabus	Schedule
Unit-I **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.	**15 days**
Unit-II **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.	**12 days**
Unit-III **Nanomaterials based Biosensor:** Introduction and challenges of biosensor. Nanomaterials and nanodevices, nanocrystalline and carbon nanotube based biosensor.	**10 days**
Unit-IV **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.	**13 days**
Unit-V **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.	**13 days**
CIA Tests, Seminars, Presentations, Reviews, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar - Sensor, Biosensor and Nanomaterials based Biosensor (502504)

1. Define sensor and uses.
2. Highlight the principle and application of biosensor.
3. Illustrate with example of optical and chemical sensor.
4. Differentiate between chemical and biological sensor.
5. Define Avidin-Biotin mediated biosensor by electrochemical technique?
6. Write an essay on luminescent and glucose biosensors.
7. Explain the detail about how to immobilization of enzyme through the Avidin-Biotin modified system.
8. Describe the carbon nanotube based biosensor.
9. Differentiate between nanodevice and nanocrystalline biosensor.
10. Write a short note on biological oxygen demand biosensor.

Code: 502505 Molecular Interactions

Program: M.Sc.,	Semester: III (2019-20)
Course Title and Code: **Molecular Interactions** (502505)	Class Time: Candidates are selecting the course
Name of the Course Teacher	-
Mobile: -	Email: -

Course Brief:

Molecular interactions deal with nucleic acids and proteins and how these molecules interact with one another in a cellular environment to promote and regulate the normal physiological processes defining proper growth, division, and development. This course will emphasize on the basics of orbital atom theory, molecular mechanisms of DNA replication, repair, transcription, protein synthesis, and gene regulation followed in different organisms. Techniques and experiments used to discern these mechanisms, often referring to the original scientific literature. An in-depth look at some rapidly evolving molecular processes, including chromatin structure and function, RNA polymerase dynamics, and regulation of gene expression by different types of RNAs.

Reference(s)/ Text Books:

Text books:

1. Frenking, G. and Shaik. S. (2014). The Chemical Bond: Fundamental Aspects of Chemical Bonding, Wiley Publishers.
2. Gromiha, M.M. (2010). Protein Bioinformatics: From Sequence to Function, Academic Press, First Edition.

Reference Books:

1. Winter, M.J. (2016). Chemical Bonding. Oxford University Press, Inc., New York.
2. Meyerkord, C.L. and Fu , H. (2015). Protein-Protein Interactions: Methods and Applications, Humana Press, second edition
3. Kangueane, P. (2011). Protein-Protein Interactions. Nova science Publishers.
4. Mathura, V.S. and Kangueane, P. (2009). Bioinformatics: A Concept-Based Introduction. Springer
5. Bujnicki, J.M. (2009). Prediction of Protein Structures, Functions, and Interactions. John Wiley & Sons Ltd.
6. Albert cotton, F. (2008). Chemical Application of Group Theory. John Wiley and Sons, Inc. New York. Third edition.
7. Eliel, E. (2001). Stereochemistry of carbon compounds, Tata Mc-Graw-Hill.
8. Spice, J. E. (1964). Chemical Binding and Structure. Pergamon Press Ltd., Headington Hill Hall, Oxford. 395 pp.

Course Objectives: To make the students:

i. To explain how ionic, hydrophobic, and hydrogen bonding interactions influence the molecular pattern of Biological processes - comprehend the underlying mechanisms and its associated action.

ii. To determine the structure of nucleic acids and proteins and modulate accordingly the binding specificity between them.

iii. To distinguish different molecular biology techniques that are used to isolate, separate, and probe for specific proteins, nucleic acids, and intra molecular interactions.

iv. To identify and overcome limitations of the above mentioned techniques and employ them for a given particular biological question. Additionally, also to use appropriate experimental techniques that are best suited to answer and address for a given biological problem.

v. To compare and contrast the mechanisms of bacterial and eukaryotic DNA replication, repair, transcription, and translation and explain how a change in DNA topology – chromatin structure could affect these processes.

vi. To offer instances of DNA and histone modifications and their aftermaths in gene expression

vii. To describe molecular mechanisms by which DNA can be damaged and identify different protein complexes that could repair different forms of DNA damage.

viii. To understand how homologous recombination, site-specific recombination, and transposition can promote both genome stability and genetic diversity;

ix. To compare and contrast various ways in which gene expression is regulated by small RNAs; to interpret and analyze data from primary research articles; to write a review about a primary research article

Course Outcomes: The students shall be able to

i. How changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
ii. Connection between the sequence and the subcomponents of a biological polymer and its properties.
iii. Predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule.
iv. Evaluate scientific questions of the concerning organisms that exhibit complex properties due to the interaction of their constituent parts.
v. Define representations and models that illustrate the interactions between biochemistry, parts and reactions.
vi. Analyze data to identify how molecular interactions affect structure and function.
vii. Explanations based on evidence of how variation in molecular units provides cells with a wider range of functions.
viii. Describes the relationship between enzyme structure and function
ix. Predict the effect of various environmental conditions/changes to the function of enzymes.
x. Determine the biologically important factors affecting enzyme activity.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions
- Case-studies and Review questions
- Practical Classes.

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
3 hour tests for 75 marks and converted to 15 marks	Assignments, reviews and Seminars for 10 Marks	Three Hour examination on the whole syllabus for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance has been taken will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per academic calendar		After CIA Test-I	

Course Outline: Molecular Interactions (502505)

- The course will help to analyze data to identify how molecular interactions affect structural and functional mechanism in detail.
- It enumerates the explanations based on evidence of how variation in molecular units provides cells with a wider range of functions.

- On completion of the course the student will be able to describe the relationship between enzyme structure and function and to predict the effect of various environmental conditions/changes to the function of enzymes.
- Determine the biologically important factors affecting enzyme activity.
- The course content includes Fundamentals of atomic and molecular orbitals; Fundamentals of chemical bonding and non-bonding interactions; Folding pathways; Molecular interactions (protein-protein, protein-DNA, DNA-Drug, Protein-Lipid, Protein-Ligand, Protein-Carbohydrate interaction, Metalloprotein. Pi … Pi interactions, C-H…Pi interactions) and Spectroscopy.

More books for Reading and Referencing

Physical Chemistry: Quantum Chemistry and Molecular Interactions by Andrew Cooksy; 2013 **ISBN-10: 0321814169, ISBN-13: 978-0321814166**.
Molecular Interactions in Bioseparations; Editors: That T. Ngo; 1993 **ISBN: 978-1-4899-1872-7**
Physical Chemistry, Mastering Chemistry Access Code: Quantum Chemistry and Molecular Interactions by Andrew Cooksy; 2013 **ISBN 10: 0321784405 ISBN 13: 9780321784407**
Electron Dynamics in Molecular Interactions; Principles and Applications; By (author): Frank Hagelberg (East Tennessee State University, USA); 2014 **ISBN: 978-1-84816-487-1**
Chromatographic Determination of Molecular Interactions Applications in Biochemistry, chemistry and Bio-Physics By Tibor Cserhati, Klara Valko; 2010 **ISBN-13: 978-0849344374, ISBN-10: 0849344379**

Molecular Interactions

Syllabus	Schedule
Unit-I **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.	**4 days**
Unit-II **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-	**4 days**

VSEPR Theory, hydrophobic interactions, electrostatic interactions, van der Waals interactions, hydrogen bonds.	
Unit-III **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	**5 days**
Unit-IV **Molecular interactions:** protein-protein, protein-DNA, DNA-Drug, Protein-Lipid, Protein-Ligand, Protein-Carbohydrate interaction, metal coordination in metalloproteins, Inter and intra molecular interactions.	**3 days**
Unit-V **Experimental and Computational methods:** Principles, Theory, Instrumentation and Application of ITC, SPR, Fluorescence techniques to bimolecular interactions. Databases and tools like DIP, INTACT etc.,	**3 days**
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance.	**3 days**

Assignment & Seminar - Molecular Interactions (502505)

- Theory of atomic and molecular orbitals;
- Valency bond theory and molecular orbital theory;
- Shape of orbitals and hybridization.
- Instrumentation and Application of UV, IR, NMR and Circular dichroism (CD) to macro molecules.
- Stereochemistry of proteins and nucleic acids.
- Molecular interaction between Protein-Carbohydrate; Metalloprotein; Pi…Pi interactions, and C-H…Pi interactions.

Code: 502506 Introduction to Neural Networks

Program: M.Sc.,	Semester: III (2019-20)
Course Title and Code: **INTRODUCTION TO NEURAL NETWORKS (502506)**	Class Time: Candidates are selecting the course
Name of the Course Teacher	-

Mobile: -	Email: -

Course Brief:

The course introduces the theory and practice of neural computation. It offers the principles of neurocomputing with artificial neural networks widely used for addressing real-world problems such as classification, regression, pattern recognition, data mining, time-series modelling, etc. Two main topics are covered: supervised and unsupervised learning. Supervised learning is studied with linear perception models, and non-linear models such as multilayer perceptrons and radial-basis function networks. Unsupervised learning is studied using Kohonen networks. Recurrent networks of the Hopfield type are briefly covered. There are offered contemporary training techniques for parameter learning in all these neural networks. Program implementations in Mat lab of the studied neural networks are provided. The objective of this course is to make students learn about concepts of artificial intelligence and applications of artificial intelligence in bioinformatics.

Reference/Text Books:

Text Books:

1. Daniel Graupe (2013). Principles of Artificial Neural Networks, Third edition, World Scientific Publishing Co. Pte. Ltd.
2. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, (2013),"Introduction to Statistical Learning", Springer.

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville ,(2016),"Deep Learning", MIT Press .
2. Raúl Rojas, (2013)," Neural Networks: A Systematic Introduction", Springer Science & Business Media.
3. Christopher M. Bishop , (2013)," Pattern Recognition and Machine Learning", Springer.
4. David W. Pearson, Nigel C. Steele, Rudolf F. Albrecht ,(2012) "Artificial Neural Nets and Genetic Algorithms", Springer Science & Business Media
5. . Richard O. Duda, Peter E. Hart, David G. Stork ,(2012)," Pattern Classification", John Wiley & Sons, Second Edition.

Course Objectives: To make the students:

i. To introduce the neural networks for classification and regression.
ii. To give design methodologies for artificial neural networks.
iii. To provide knowledge for network tuning and over fitting avoidance.
iv. To offer neural network implementations in Mat lab.
v. To demonstrate neural network applications on real-world tasks.

Course Outcomes: The students shall be able to

i. Introduce the main fundamental principles and techniques of neural network systems.
ii. Design single and multi-layer feed-forward neural networks.
iii. Develop and train radial-basis function networks.
iv. Understand the differences between networks for supervised and unsupervised learning
v. Analyze the performance of neural networks.
vi. Investigate the principal neural network models and applications

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Case-studies and refer question bank

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, seminars, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic

malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Introduction to Neural Networks (502506)

- Introduction to neural networks.
- Basics of network training.
- Probability density estimation.
- Multi-layer perceptrons.
- Radial basis function networks (RBFNs)
- Committee Machines and Mixtures of Experts.
- Content includes: Support Vector Machines (SVMs), Neural Networks for Robot Control.

More books for Reading and Referencing

Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications Rajasekaran**; 2017**, **ISBN**: 978-812-035-334-3
Neural Networks & Learning Machines Pearson Education India; Third edition Haykin; 2009; **ISBN -10:** 0-13-147-139-2 and **ISBN-13:** 978-0-13-147139-9
Artificial Intelligence 3e: A Modern Approach Russell; 2015, **ISBN-10:** 933-254-351-8 and **ISBN-13:** 978-933-254-351-5
Machine Learning Tom M. Mitchell; 1997 **ISBN:** 0071154671 and **ISBN:** 978-007-115-467-3

Introduction to Neural Networks

Syllabus	Schedule
Unit-I **Introduction to Neural Networks**: History, Biological Neurons and Neural Networks. Artificial Intelligence (AI) - Artificial Neurons, Networks of	**8 days**

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.	**10 days**
Unit-III **Bias and Variance**: Under-Fitting and Over-Fitting, Improving Generalization.	**6 days**
Unit-IV **Applications of Multi-Layer Perceptrons**: Radial Basis Function Networks: Introduction, Radial Basis Function Networks: Algorithms and Applications, Committee Machines.	**8 days**
Unit-V **Self Organizing Maps**: Fundamentals, Self Organizing Maps: Algorithms and Applications, Learning Vector Quantisation, Overview of More Advanced Topics.	**5 days**
CIA Tests, Seminars, Presentations, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar - Introduction to Neural Networks (502506)

- Describe the relation between real brains and simple artificial neural network models.
- Explain and contrast the most common architectures and learning algorithms for Multilayer Perceptrons, Radial-Basis Function Networks, Committee Machines, and Kohonen Self-Organizing Maps.
- Discuss the main factors involved in achieving good learning and generalization performance in neural network systems.
- Describe the equations using vector expressions.
- Identify the main implementation issues for common neural network systems.

Evaluate the practical considerations in applying neural networks to real classification and regression problems.

Code:502507 Data Warehousing and Data Mining

Program: M.Sc.,	Semester: II (2019-20)
Course Title and Code: **Data Warehousing and Data Mining (502507)**	Class Time: Candidates are selecting the course
Name of the Course Teacher	-
Mobile: -	Email: -

Course Brief:

Data mining, *the extraction of hidden predictive information from large databases*, is a powerful new technology with great potential to help companies focus on the most important information in their data warehouses. Data mining tools predict future trends and behaviors, allowing businesses to make proactive, knowledge-driven decisions. The automated, prospective analyses offered by data mining move beyond the analyses of past events provided by retrospective tools typical of decision support systems. Data mining tools can answer business questions that traditionally too time consuming to resolve. They scour databases for hidden patterns, finding predictive information that experts may miss because it lies outside their expectations. Thus, Introduction to Database Management Systems will concentrate on the principles, design, implementation and applications of database management systems.

Reference/Text Books:

Text Books:

1. Kimball, R. (2013), "The Data Warehouse Toolkit", John Wiley.
2. Kamber, H., Kaufmann, M. (2011), "Data Mining Concepts and Techniques".

Reference Books:

1. Ian H. Witten, Eibe Frank, Mark A. Hall, Christopher J. Pal, (2016),"Data Mining", Morgan Kaufmann, Fourth Edition.
2. Michael W. Berry and Jacob Kogan, (2010),") Text Mining Applications and Theory", John Wiley & Sons.

3. Feldman, R and Sanger, J. (2007) "The Text Mining Handbook: Advanced approaches in analyzing unstructured data"; Cambridge University Press.
4. Xiaohua Hu and Yi Pan (2007), Knowledge Discovery in Bioinformatics, John Wiley & Sons.
5. William H. Inmon, (2005),"Building the Data Warehouse", John Wiley & Sons, Fourth Edition.
6. Dunham, M.H. (2006) "Data Mining Introductory and Advanced Topics", Pearson Education.
7. Mallach, (2002)." Decision Support And Data Warehouse Systems", Tata McGraw-Hill Education.

Course Objectives: To make the students:

i. To introduce students to the basic concepts and techniques of Data mining and Data Warehousing.

ii. To develop skills of using recent data mining software for solving practical problems

iii. To gain experience of doing independent study and research

iv. To study the methodology of engineering legacy databases for data warehousing and data mining to derive business rules for decision support systems

v. Develop and apply enthusiasm for learning. Class participation is encouraged in this course.

Course Outcomes: The students shall be able to

i.	Understand data mining principles and techniques: Introduce DM as a cutting edge business intelligence method and acquaint.
ii.	To understand concepts of Data warehousing, components of data warehousing and design schemas
iii.	To understand the concepts of OLAP and OLAP tools. To understand the clustering methods and apply algorithms to datasets.
iv.	the concepts of mining methods and classification types and apply the algorithms to datasets
v.	DM techniques for building competitive advantage through proactive analysis, predictive modelling, and identifying new trends and behaviour's.

vi.	Learning how to gather and analyze large sets of data to gain useful business understanding.
vii.	Learning how to produce a quantitative analysis report/memo with the necessary information to make decisions.
viii.	Describing and demonstrating basic data mining algorithms, methods, and tools, Identifying business applications of data mining.
ix.	Overview of the developing areas - web mining, text mining, and ethical aspects of data mining.
x.	Differentiate database system from file system by enumerating the features provide by database system and describe each in both function and benefit.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Lectures covering the Practical part using PowerPoint presentations.
- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Case-studies and Discuss model question bank.

Grading System

< 50 Marks in all	50 < Marks < 59	60 < Marks < 75	Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on CIA exams, assignments, seminars, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignment, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Attendance and participation are vital to the student's success in this course. Students are expected to attend class every day. Minimum attendance to be eligible to take end-semester-examination is 80%. It is also essential that the students study regularly.

Punctuality: Punctuality is very important in the course, because if student are late, you not only waste your time, but other student's. You will also disturb others when you go into the lecture class or laboratory after the class begins. Therefore, please arrive at the class on time. Names of late students will be recorded by mentor and marks from Course performance will be deducted. An excuse for being absent from class shall be a medical or personal emergency acceptable at the discretion of the Head of the Dept.

Class Participation: Class participation and interaction helps to form a complete educational experience. However, class participation and interaction is to be relevant to course content and context. Deviant behavior may lead to dismissal or suspension.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

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Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar

As per Academic Calendar	After CIA Test-I

Course Outline: Data Warehousing and Data Mining (502507)

- Databases to enable decision support through warehousing and mining of data.
- Areas with data mining will include justifying the need for knowledge recovery in databases, data mining methods such as clustering, classification, Bayesian networks, association rules, and visualization.
- Data warehouse including efficient data retrieval using bitmap and join indexes, reporting, ad hoc querying, and multi-dimensional operations such as slicing, dicing, pivoting, drill-down, and roll-up operation.
- Data extraction, transformation, loading techniques for data warehousing.
- Machine learning schemes in data mining.
- Database Concepts and Architecture
- Data Modeling using Entity Relationship Diagrams
- Referential integrity, entity integrity, and other constraints. Defining a relational schema from an ER diagram**.**
- Machine learning schemes in data mining

More books for Reading and Referencing

Data Warehousing and Mining - 2012 ITLESL, Pearson Education India **(ISBN : 8131799050, 9788131799055)**
Data Mining Data Warehousing and Olap – 2009 Gajendra Sharma, S. K. Kataria & Sons **(ISBN: 8189757474, 9788189757472)**
Data Warehousing Olap And Data Mining –2006 S. Nagabhushana, New Age International **(ISBN: 8122417647, 9788122417647)**
Data Warehousing: Architecture and Implementation – 1999 Mark Humphries, Michael W. Hawkins, Michelle C. Dy, Prentice Hall Professional and **(ISBN:0130809020, 9780130809025)**

Data Warehousing and Data Mining

Syllabus	**Schedule**

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.	**13 days**
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.	**17 days**
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.	**15 days**
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.	**14 days**
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	**18 days**

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	
CIA Tests, Seminars, Presentations, Reviews, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar - Data Warehousing and Data Mining (502507)

- Introduction to the process of knowledge discovery in databases
- The role of OLAP server.
- Basic concepts of data warehousing and data mining
- Data warehouse design and implementation: multidimensional data model, case study using Oracle technology
- Data mining core algorithms: statistical modeling, classification, clustering, association rules
- Patterns of data mart development.
- Providing OLAP (On-line Analytical Processing) to User-Analysts.
- Designing GUI based on a data mining query language
- Descriptive statistical measures in large databases Data Mining Primitives, Languages, and System Architectures.
- Database Support to Data Mining
- Association rules and Knowledge Discovery process
- Data Warehousing Technology.
- Prism Solutions.
- Analytical characterization
- Discuss about Introduction to Distributed Database Processing
- model development, schema design for a data warehouse
- Explain DBMS functions.
- Purpose of building a DBMS system and RDBMS system
- Compare between File systems and database systems
- Explain the relational model with suitable example
- Reducing E-R Diagrams to tables
- Define the following terms

a. Tuple

b. Attribute

c. Domain

d. Primary Key

e. Foreign Key

Code: 502508 Programming in C and C++

Program: M.Sc.,	Semester: II (2019-20)
Course Title and Code: **Programming in C and C++ (502508)**	Class Time: Candidates are selecting the course
Name of the Course Teacher	-
Mobile: -	Email: -

Course Brief:

This course provides a fast-paced introduction to the C and C++ programming languages. To learn the required background knowledge, including memory management, pointers, preprocessor macros, object-oriented programming, and how to find bugs when inevitably use any of those incorrectly. In computing, C is a general-purpose computer programming language used along with the UNIX operating system. Although C was designed for implementing system software, it is also used for developing application software. It is widely used on different types of software platforms and computer architectures, and several popular compilers exist. C has greatly influenced many other popular programming languages.

C++ Language is one of the approaches to provide object-oriented functionality with C like syntax. C++ adds greater typing strength, scoping and other tools useful in object-oriented Programming and permits generic programming via templates. It is regarded as a middle-level language, as it comprises a combination of both high-level and low-level language features. Some of its application domains include systems software, device drivers, embedded software, high-performance server and client applications, and entertainment software such as video game. The practical part of this course is covered in the lab through exercises, practical assignments, and tutorials.

Reference/Text Books:

Text Books:

1. E. Balagurusamy (2017), "Programming in ANSI C ", Tata McGraw- Hill Education, Seventh Edition.
2. Herbert Scheldt (2009),"C++: The Complete Reference", Tata McGraw- Hill Education, Fourth Edition.

Reference Books:

1. Jesse Liberty, (1998),"Teach Yourself C++ in 21 Days", Sams Publishing 2nd edition. Marshall A. D, (1999),"Programming in C", Nikos Drakos.
2. Brian W. Kernighan, Dennis Ritchie, (1988),"The C programming Language", Prentice Hall.
3. Michael Barr, (1999)," Programming Embedded Systems in C and C++ ", O'Reilly.
4. Guigo, R. & Gilbert D., (2002) "Algorithms in bioinformatics", Springer- Verlag, Berlin.
5. Dan Gookin, (2004) "C for Dummies", John Wiley & Sons, 2nd edition.
6. Parthasarathy, S. (2008), "Essentials of C Programming for Life Sciences", Ane's Books India, New Delhi. Y. Daniel Liang, (2011)," Introduction to Programming with C++", Pearson Education, Second Edition.
7. Y. Daniel Liang, (2011)," Introduction to Programming with C++", Pearson Education,Second Edition.
8. Debasish Jana, (2014),"C++ and Object Oriented Programming Paradigm", PHI Learning, Third Edition.
9. Yashavant P. Kanetkar, (2016) "Let Us C", BPB Publications, Thirteen Edition.

Course Objectives: To make the students:

i. To learn the fundamental programming concepts and methodologies which are essential to building good C/C++ programs.
ii. To practice the fundamental programming methodologies in the C/C++ programming language via laboratory experiences.
iii. To code, document, test, and implement a well-structured, robust computer program using the C/C++ programming language
iv. Be able to apply object oriented or non-object oriented techniques to solve bigger computing problems

Course Outcomes: The students shall be able to

i.	Be able to implement, test, debug, and document programs in C and C++.
ii.	Understand low-level input and output routines.
iii.	Program with pointers and arrays, perform pointer arithmetic, and use the pre-processor. Be able to write programs that perform explicit memory management.
iv.	Understand how to write and use functions, how the stack is used to implement function calls, and parameter passing options.
v.	Understand and use the common data structures typically found in C programs - namely arrays, strings, lists, trees, and hash tables.
vi.	Create programs that measure or simulate performance and use them to analyze behaviour.
vii.	Use UNIX commands to manage files and develop programs, including multi-module programs and make files

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Lectures covering the theoretical part using PowerPoint presentations.
- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Case-studies and Review questions

Grading System

< 50 Marks in all	50 < Marks < 59	60 < Marks < 75	Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews, seminar and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75%

attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10 mins after the attendance will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class/Lab Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic

malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test I	

Course Outline: Programming in C and C++ (502508)

- Introduction to compiling and software development life cycle
- Basic scalar data types, operators, variables, statements, flow control, streamed input/ output, conversions, preprocessor.
- Declaring, defining and invoking functions
- Strings processing, exceptions handling, dealing with namespaces
- Object-oriented approach
- It discusses class and objects
- Defining overloaded operators, File input and output functions.
- The above said methods are used to create a bioinformatics related programs in C and C++.

More books for Reading and Referencing

C++ Programming Today – 2011 Johnston**,** Barabara **: ISBN-10: 812-033-831-6, ISBN-13**: **978-812-033-831-9**
Practical C++ Programming – 2003 Steve Oualline**,**'O'Reilly Media, Inc and **(ISBN: 0596004192, 9780596004194**)
Advanced Graphics Programming In C & C++ - 1993 Roger T. Stevens,BPB Publications and **(ISBN: 817029228X, 9788170292289)**
Computer Programming with C++ - 2017 **Kunal Pimparkhede**, Cambridge University Press, **(ISBN**: **1316506800, 9781316506806)**

Code: 502508 Programming in C and C++

Syllabus	Schedule
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.	**17 days**
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.	**10 days**
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.	**10 days**
Unit-IV **Introduction to C++:** Object oriented programming concepts-inheritance, polymorphism, and encapsulation. Error handling, Exception handling, Memory management, Files I/O.	**10 days**
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.	**9 days**
CIA Tests, Seminars, Presentations, Reviews, Assignments, Journal club and Career Guidance.	**5 days**

Practical, Assignment & Seminar - Lab-I - Programming in C and C++ (502508)

- **To describe the advantages of a high level language like C/C++, the programming process, and the compilation process.**
- **To describe and use software tools in the programming process.**
- Use an IDE to compile, load, save, and debug a C/C++ program.
- Create and analyze algorithms for solving simple problems.
- Analyze, explain and trace the behavior of simple programs involving the fundamental programming constructs addressed in the course.
- Write programs that use each of the following fundamental programming constructs: basic computations, simple console I/O, standard conditional and iterative structures (including pretest and posttest loops, counter-controlled loops, and conditionals).
- **To demonstrate an understanding of primitive data types, values, operators and expressions in C/C++.**
- Describe automatic type conversion rules, related issues of magnitude and precision, type casting, and determine the value and type of an expression involving mixed types.
- Find mismatches between two sequences of same length, Pass the value to a function using pointer.
- Convert NCBI format file to fast a sequence file, Find GC content using Structures

Code: 502509 Cell Communication and Cell Signaling

Program: M.Sc.,	Semester: II (2019-20)
Course Title and Code: **Cell Communication and Cell Signaling (502509)**	Class Time: Candidates are selecting the course
Name of the Course Teacher	-
Mobile: -	Email: -

Course Brief:

Cell communication and cell biology course deals with the molecular biology of cell signaling. The students will gain an insight into the fundamental processes of the cell to cell communication and signaling uptake of molecules by membrane receptors, including membrane-protein and protein-protein interactions, and their associated effectors. Students will learn about Morphogenesis and organogenesis. The second half of lectures will deal with cell cycle signaling system and cell death.

References/Text Books:

Text Books:

1. Pfeffer U (2013) Cancer Genomics; Springer.
2. Scott F. Gilbert (2013) Developmental Biology; Tenth Edition; Sinauer Associates, Inc., Sunderland, USA.

References:

1. Henry C. Pitot (2002) Fundamentals of Oncology; Fourth Edition, Revised and Expanded; Marcel Dekker, Inc., New York, USA.
2. Wolfgang Arthur Schulz (2005) Molecular Biology of Human Cancers; An Advanced Student's Textbook; Springer, USA.
3. Raymond W. Ruddon, Daniel D. Loeb (2007) Cancer Biology; Fourth Edition; OXFORD University Press, New York, USA.
4. Bunz F (2016) Principles of Cancer Genetics; Springer.

Course Objectives:

i. To study the cellular morphology, function and to develop an understanding of genome organization.

ii. To underpin the more advanced concept those are covered experimental basis of current understandings, new experimental methodologies in molecular cell biology techniques.

Course Outcomes:

i. Students will learn about Morphogenesis and organogenesis to describe how cells exploit signaling components to assemble the specific signaling pathways.
ii. Student will be able to learn components and properties of major cell signaling pathways in control of gene expression and cellular metabolism.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions
- Case-studies and Review questions

Grading System

<50 Marks in all	50< Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, seminars, reviews and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		End-Semester Exam: 75 Marks
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Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance has been taken will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience.

Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

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Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	II CIA Test	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Core: Cell Communication and Cell Signaling (502509)

- Basic concepts about the Host parasitic interactions – understanding the entry process of different pathogens.
- Exploring the virus-induced cell transformation and pathogen induced diseases in animals and plants.

- Cell-Cell fusion method in both normal and abnormal cells.
- Cell signaling mechanism in cells, hormones and their receptors.
- Signaling through G-protein coupled receptor.
- Principles of cellular communication and regulation of hematopoiesis.
- Cell adhesion and role of different adhesion molecules.
- Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes.
- Programmed cell death, aging and senescence.
- Morphogenesis and organogenesis in animals and plants.

More books for Reading and Referencing

Molecular Cell Biology (Fourth Edition) by Harvey Lodish, Arnold Berk, David Baltimore; 1999, **ISBN-13: 978-0716737063, ISBN-10: 071673706X**
Handbook of Cell Signaling by Edward A. Dennis; 2009, **ISBN: 9780123741455**
Handbook of Cell Signaling (Second Edition) by Ralph A. Bradshaw and Edward A. Dennis; 2015; **ISBN: 978-0-8153- 4244**
Cell Signaling: principles and mechanisms by Wendell Lim, Bruce Mayer, Tony Pawson
Cell Communication: Understanding how Information is Stored and Used in Cells by Michael Friedman, Brett Friedman, 2005; **ISBN 10: 1404203192, ISBN 13: 9781404203198**
Cell-to-Cell Communication by Walmor C. De Mello; 2012; **ISBN 13:978-1-4612-9006-7**

Cell Communication and Cell Signaling

Syllabus	Schedule
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.	4 days

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 chemotaxis and quorum sensing.	4 days
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.	3 days
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.	3 days
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.*	3 days
CIA Tests, Seminars, Presentations, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar: Cell Communication and Cell Signaling (502509)

1. Describe signal transduction pathways.
2. Discuss about the cell signaling pathways.
3. What are bacterial chemotaxis and quorum sensing?
4. Describe virus-induced cell transformation
5. Write about G-protein coupled receptors
6. Explain the pathogen-induced diseases in animals and plants.
7. Define Regulation of hematopoiesis and its regulation.
8. Discuss about the neurotransmission.
9. Give an account on cell adhesion and roles of different adhesion molecules.
10. Define bacterial and plant two-component systems?

Code: 502510 Big data analysis and Next Generation Sequencing

Program: M.Sc., Bioinformatics	Semester : IV (2019-20)
Course Title: **Big data analysis and Next Generation Sequencing (502510)**	Class Time: Candidates are selecting the course
Name of Course Teacher	Dr. Sanjeev Kumar Singh & Dr. M. Karthikeyan
Mobile: +91 - 98944 29800 & +91 - 94869 81874	Email : skysanjeev@gmail.com & mkbioinformatics@gmail.com

Course Brief:

The course portrays the crucial ideas of Essential Packages and libraries, operators, Data structures, control loops of R-language; file operations, graphic libraries and plots; Overview of Statistical packages and bioconductor libraries, Data representation in R; concepts and Principles of Genomics/Epigenomics, methods of Sequencing: Sanger's dideoxy method, Microarray and RNA-seq, Next Generation Sequencing technology; Impact of transcriptomics on biology; Data analysis: NGS, Big Data, microarray; Mapping

algorithms. Measuring gene, lncRNA, siRNA from RNA-seq, NGS data; Sequence assembly concepts, challenges and Algorithms for assembling short reads using graph theory, Gene prediction, annotation and gene ontology (GO); Identification genetic variants from genome sequence: SNPs, SNVs, translocation, copy number variation; Gene expression analysis, Differential expression analysis, Hidden Markov model annotating histone markers, Cloud computing.

Reference/Text Books:

Text Books:

1. Momiao Xiong "Big Data in Omics and Imaging: Association Analysis" (2017), CRC Press, **ISBN:** 978-1-4987-2578-1
2. Peter Dalgaard "Introductory Statistics with R" (2015) Second Edition, Springer Science & Business Media. **ISBN:** 978-0-387-79053-4

References Books:

1. Laurens Holmes "Applied Epidemiologic Principles and Concepts" (2017), CRC, **ISBN:** 978-1-4987-3378-6
2. Greg J. Hunt, Juergen R. Gadau "Advances in Genomics and Epigenomics of Social Insects" 1st Ed, (2017). Frontiers
3. Ka-Chun Wong "Big Data Analytics Genomics" (2016), Springer, **ISBN:** 978-3-319-41279-5
4. Ion Mandoiu, Alexander Zelikovsky "Computational Methods for Next Generation Sequencing Data Analysis" (2016) John Wiley & Sons.
5. Shui Qing Ye "Big Data Analysis for Bioinformatics and Biomedical Discoveries" (2016), CRC, **ISBN :** 978-1-4987-2454-8
6. Ion Mandoiu, Alexander Zelikovsky "Computational Methods for Next Generation Sequencing Data Analysis" (2016), John Wiley & Sons, **ISBN:** 9781119272175
7. Hyunjoung Lee, Il Sohn "Fundamentals of Big Data Network Analysis for Research and Industry" (2016), John Wiley & Sons, **ISBN:** 978-1-1190-1558-1
8. Andrew E. Teschendorff "Computational and Statistical Epigenomics" (2015), Springer, **ISBN:** 978-94-017-9929-3
9. Kuo Ping Chiu "Next-Generation Sequencing and Sequence Data Analysis" (2015), Bentham Science, **ISBN:** 978-1-68108-093-2
10. Nathalie Japkowicz, Jerzy Stefanowski "Big Data Analysis: New Algorithms for a New Society" (2015) Springer

11. Andrew E. Teschendorff "Computational and Statistical Epigenomics" (2015) Springer
12. Hadley Wickham , 2013,Advanced R programming.
13. Ken A. Aho “Foundational and Applied Statistics for Biologists Using R” (2013) CRC, **ISBN**: 978-1439873380
14. Norman Matloff - UC Davis , 2009 The Art of R Programming.
15. W. N. Venables, D. M. Smith - Network Theory , 2nd Ed, 2009; An Introduction to R.
16. Daniel P. Berrar, Werner Dubitzky, Martin Granzow "A Practical Approach to Microarray Data Analysis" (2003) Springer

Course Objectives: To make the students:

i. To make students understand the use of R in Data representation, File Input/Output operations; Big Data Analysis and Next Generation Sequencing;

ii. To provide the student with a strong foundation for principles, methods and concepts of sequencing, Impact of transcriptomics on biology

iii. To create students opportunity to analyze the Big Data, NGS, Microarray, RNA-Seq of gene, lncRNA, siRNA

iv. To make the students look the Identification genetic variants from genome sequence; small RNA analysis, validation of whole-genome database.

v. To find out the methods for analyzing the Gene expression, Differential expression, Allele-specific expression and Statisitcal considerations.

Course Outcomes:

i. The student should be able to understand basic use of R statistical package in biological data
ii. The student will have the capacity to comprehend the ideas of Genome projects of model organisms , Next Generation Sequencing technology
iii. The students will be able to demonstrate Microarray data analysis, Genome-wide annotation methods; identification of synteny between various genomes and challenges
iv. The students will be able to analyze SNPs, SNVs, translocation, copy number variation, Concepts and algorithms to measure transcriptional regulation
v. The student should understand the Differential expression analysis of gene, the Statistical methods on rare variants

Teaching Methods: The mode of teaching is based on the following learning activities:

- Lectures covering the theoretical part will be delivered using PowerPoint presentations.

- A set of laboratory exercises to analyze biological problems using softwares and tools to develop student's interests in scientific discovery.
- Case studies in informatics-based research.

Grading System

< 50 Marks in all	50 < Obtained Marks < 59	60 < Obtained Marks < 75	Obtained Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: The students are expected to attend the classes regularly, since regular attendance is essential to gain academic achievement. As per the University norms, the students having a minimum scale of 70-75% attendance are only qualified to write their end-semester examinations.

Punctuality: Punctuality is the most important quality for the student to be followed and maintained to achieve success. Students who arrive late by 10 mins to the class without any vital reason will be marked absent in the attendance register. On the other hand, valid excuse including personal or medical emergency is acceptable, with prior consent by the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking practice and much more that will provide a wholesome enriched classroom experience. When students participate, they learn from one another and gain their knowledge better.

Submission of Assignment: Assignments are given to students in order to apply the concepts for deeper understanding of the subject. Therefore, each student will be allocated two assignments for the course, covering the entire topic. Students will be given deadline to submit the assignment by the course instructor and good preparation of assignment will help the students for their final exams.

Presentation of Seminar: Apart from the assignments, students are supposed to give an oral presentation during the class seminar hours in their assigned topic. The concerned instructor will encourage the participants to ask valid questions during seminar

presentation in order to put up their confidence levels and communication skills. In addition, students will be able to gain information and can be updated in their course.

Preparedness: At the end of every class, the concerned instructor conveys the students about the details that will be handled in the next class to increase the student's awareness related to the topics.

Academic Dishonesty: Academic dishonesty is a completely unacceptable mode of conduct and every student should be aware of this important aspect. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Depending upon the requirement of student's possibility, the course syllabus will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairperson.

Important dates: Scheduled dates for the various activities related to the course

CIA Test I	CIA Test II	Assignment I	Assignment II	Seminar
As per Academic Calendar		After CIA tests		

Course Outline: Core: Big Data Analysis and Next Generation Sequencing (502510)

- Essentials of R-Package, libraries, operators, control loops in biological data, statistical packages and bioconductor libraries in R, Qualitative and quantitative data types; plotting of data
- Concepts of genomics and epigenomics, methodology and principle of sequencing, Genome projects of model organisms, ChIP-chip ChIP-seq- techniques, Methylation of DNA and genetics; volume of data produced and important repositories
- Analysis of data: gene expression analysis, statistical methods, Mapping algorithms such as Burro-Wheeler; Measuring gene, lncRNA, siRNA from RNA-seq NGS data; Gene prediction and annotation; gene ontology (GO); Genome-wide annotation methods; Algorithms for assembling short reads using graph theory such as Hamiltonian cycle and de Brjin;
- Genetic variants identification from genome sequence; preface to various applications. Concepts and algorithms to measure transcriptional regulation, small RNA analysis, validation of whole-genome database

- Finding of differential Gene and Allele-specific expression, Organizing genetic, Non-synonyms (SIFT, Polyphen), Regulatory and Synonyms variants, , Hidden Markov model annotating histone markers,

More books for Reading and Referencing

The R Book-**Michael J Crawley** Publisher: John Wiley & Sons, January 1, 2007. (**ISBN**: 978-0-470-97392-9)
Data Analysis and Graphics: Using R - **J. H. Maindonald and John Braun** Publisher: Cambridge University Press, 06-May-2010. (**ISBN**: 978-0-521-76293-9)
Epigenetics: Current Research and Emerging Trends - **Brian P. Chadwick** Publisher Caister Academic Press, July 2015. (**ISBN: 978-1-910190-07-4**)
Non-coding RNAs and Epigenetic Regulation of Gene Expression: Drivers of Natural Selection - **Kevin V. Morris** Publisher: Caister Academic Press, February 2012. (**ISBN: 978-1-904455-94-3**)
Computational Methods for Next Generation Sequencing Data Analysis- **Ion Mandoiu, Alexander Zelikovsky** Publisher: John Wiley & Sons, October 2016. (**ISBN: 978-1-118-16948-3**)
Next-Generation Sequencing Data Analysis- **Xinkun Wang** Publisher: CRC Press , February 24, 2016 (**ISBN: 978-1-482-21788-9**)

Big Data Analysis and Next Generation Sequencing

Syllabus	**Schedule**
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.	**10 days**
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,	**10 days**

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 **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.	**14 days**
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.	**10 days**
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.	**14 days**
CIA Tests, Seminars, Presentations, Assignments, Reviews, Journal club and Career Guidance.	**8 days**

Assignment & Seminar - Big Data Analysis and Next Generation Sequencing (502510)

1. Microarray data analysis
2. Differential expressed gene finding

3. Next Generation Sequencing technology
4. Line plot, scatter plot, frequency histograms, pie-chart, heat map and 3D plots using R.
5. NGS data analysis
6. Genome-wide annotation methods
7. Identification SNPs
8. Hidden Markov model
9. Use bioconductor for analysis of microarray data using R

Code: 502511 General Microbiology

Program: M. Sc	Semester : IV (2019-20)
Course Title: **General Microbiology (502511)**	Class Time: Candidates are selecting the course
Name of Course Teacher	
Mobile:	Email :

Course Brief:

This course explain the contributions of various scientist to the field of Microbiology, different system classification, basic structure and morphology of bacteria, reserve food materials, functions of different cell organelles, morphology of cyanobacteria and archaebacteria, classification of algae and fungi and their lifecycle, properties of viruses, various assay and life cycle of bacteriophages and virus related agents, Principle and applications of bright and dark field microscope, electron microscope, polarized and confocal microscope.

Reference/Text Books:

Textbooks:

1. Willey., J.M, Sherwood., L.M, & Woolverton., C.J. (2014). Prescott's Microbiology. McGraw Hill Education, Ninth Edition.
2. Wessner., D,Dupont ., C,Charles ., T,Neufeld ., J. (2013). Microbiology. Wiley, First edition.
3. Willey., J.M, Sherwood., L.M, & Woolverton., C.J. (2011). Prescott's Microbiology. McGraw Hill Education, Eighth Edition.

4. Prescott, L.M., Harley, J.P. and Helin, D.A. (2008). "Microbiology";, McGraw Hill, New York, 5th Edition.

Reference Books:

1. Tortora G.J., Funke, B.R. and Case, C.L (2016). Microbiology-An introduction, Pearson Education India, 11th Edition.
2. Tyagi., R. (2015). Advanced Applied Microbiology. D.P.S. Publishing House
3. Sharma., P.D. (2014).Microbiology. Rastogi Publications.
4. Dubey, R.C. and Maheswari, D.K. (2013). A text book of Microbiology; S. Chand and Company Ltd, NewDelhi, 3rd Edition.
5. Kreig, N.R. Whitman, W. et al, (2012) "Bergeys Manual of Systematic Bacteriology"; Springer, Volume 5.
6. Khuntia., B. K. (2011). Basic Microbiology-An Illustrated Laboratory Manual. Daya Publishing House.
7. Alcamo, I.E. (2010). "Fundamentals of Microbiology"; Addison wesley Longman, Inc. California, 9th Edition.
8. Pelczar, M.J., Chan, E.C.S and Kreig, N.R. (2009). Microbiology – An application based approach, Tata McGraw Hill Publishing Company Limited, New Delhi, 5th Edition.
9. Madigan, M.T., Martinko, J. M., Dunlap, P.V. and Clark, D.P. (2009). Brock Biology of Microorganisms, Prentice Hall, New Jerry, 12th Edition.
10. Geeta Sumbali and Merhrotra R.S. (2009).Principles of Microbiology. Tata McGraw Hill Education private Limited.
11. Glazer., A.N, Nikaido., H. (2008). Microbial biotechnology – Fundamentals of Applied Microbiology, Cambridge University Press, Second edition.
12. Wheelis, M. (2008). Principles of Modern Microbiology, Jones & Bartlett India Pvt. Ltd., New Delhi.
13. Alexopoulus, E.J., Mims, C.W. and Blackwell, M. (2007). Introductory Mycology; John Wiley and Sons, New York, 4th Edition.
14. Salle, A.J. (2007). Fundamental Principles of Bacteriology, Tata McGraw Hill Publishing Company, New Delhi, 7th Edition.
15. Clarke, A.R. and Eberhardt, C.N. (2002). Microscopy Techniques For Microscopy, CRC press.
16. Davis, B.D., Duelcco, R., Fisen, H.N. and Ginsberg, H.S. (1990). Microbiology; Harper & Row Publishers, Singapore, 4th Edition.

17. Atlas, R.M., (1987). "Microbiology Fundamentals and Applications"; MacMillan Pub. Co., New York.
18. Stainer., R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.H. (1987). The Microbial World; MacMillan Press Ltd., London, 5th Edition.
19. Chapman, V.J. and Chapman, D.J. (1980). Sea Weeds; Chapman & Hall, London, 3rd Edition.

Course Objectives:

1. To inculcate knowledge on fundamentals of microorganisms
2. To learn the structural organization, morphology and reproduction of microbes
3. To enable them to differentiate algae and fungi – Eukaryotic Microorganism
4. To know the principles of Microscopy and advancements in Microscopy
5. To learn the classification and life cycle of viruses

Course Outcomes:

The students shall be able to:

i.	Knowledge on historical perspective of Microbiology
ii..	Basic knowledge on different structure of microbes
iii.	differentiate the morphology of different algae and fungi
iv.	Ideas on different type of microscope

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	II Class	I Class	Distinction

Assessment & Evaluation: Student evaluation is based on internal exams, assignments, reviews, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 2 hour tests for 15 marks in all	Assignments, Reviews and Seminars for 10 marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75%

attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Components of Internal Assessment (Max. Marks 25)

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: General Microbiology (502511)

1. History of Microbiology
2. Various classification accepted
3. Internal and external structure of bacteria
4. Characteristics and life cycle of algae
5. Characteristics and life cycle of fungi
6. Characteristics, structural organization and life cycle of viruses
7. Principle and applications of different types of Microscope

General Microbiology

Syllabus	Schedule
Unit-I **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.	**6 hrs/week** **10 days**
Unit-II **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	**20 days**

and pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes. Reserve food materials – polyhydroxybutyrate, polyphosphates, cyanophycin and sulphur inclusions. General account on mycolpasma.	
Unit-III **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	**20 days**
Unit-IV **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	**10 days**
Unit-V **Microscopic Techniques**: Principle and application of bright field, dark field, phase contrast, fluorescence, electron microscope- TEM and SEM, Polarized Microscope and Confocal Microscopy.	**10 days**
Internal test and Department activities	**10 days**

Assignment I Morphology of Bacterial cell (502511)

1. Explain the internal structure
2. Explain the external structure
3. Draw the neat diagram of typical bacterial cell
4. Differentiate the cell wall nature of gram positive and gram negative bacteria
5. Differentiate archaebacteria and Eubacteria

Assignment II Life cycle of viruses

1. Define viruses
2. Differentiate viruses from bacteria
3. Account on viral assay methods
4. Explain the lytic life cycle

5. Explain the lysogenic life cycle

Code: 502512 Open Source in Bioinformatics

Program: M.Sc., Bioinformatics	Semester : IV (2019-20)
Course Title**: Open Source in Bioinformatics (502512)**	Class Time: 10-1 and 4-5: Tuesday
Name of Course Teacher	Dr. Sanjeev Kumar Singh, Dr. M. Karthikeyan & Dr. J. Joseph Sahayarayan
Mobile: +91 - 98944 29800 +91 - 94869 81874 & +91 - 90475 64087	Email : skysanjeev@gmail.com, mkbioinformatics@gmail.com & bioinformaticsjoseph2015@gmail.com

Course Brief:

The course will explore students about the Bioinformatics tools and data resources that are available for the understanding and development of biomacromolecular structures, focusing on how best to use structural information to expand the most from it in definite research backgrounds. More and more genomes are being sequenced and many new types of datasets are being generated in large-scale projects. This course will cover the use of publicly available resources to manage, share, analyze and interpret data and also deals with software programs that are intended for mining out the meaningful information from the mass of molecular biology or biological databases in order to carry out sequence or structural analysis. The impact of genetic variation on structure, predicting protein structure and function and exploring interactions with other macromolecules as well as with low molecular weight compounds were easily carried out by learning the applications of various tools and softwares. The course depicts the usage of Bioinformatics resources that are easily accessible and also allows students to discover interaction networks and pathways in which specific gene(s) participate. Students will gain hands-on experience using a range of data resources and tools, combined with lectures. Furthermore, there will be the prospect to discuss the challenges facing towards research works in the bioinformatics field.

Reference/Text Books:

Text Books:

1. Mandoiu, I., Zelikovsky, A. (2016). Computational Methods for Next Generation Sequencing Data Analysis. Wiley Publications.
2. Pazos, F and Monica, C. (2015). Practical Protein Bioinformatics. Springer.

Reference Books:

1. Eija Korpelainen, Jarno Tuimala, Panu Somervuo, Mikael Huss, Garry Wong, (2014). RNA-seq Data Analysis: A Practical Approach, CRC press, Taylor and Francis group.
2. David Edwards, Jason Stajich and David Hansen, (2009). Bioinformatics: Tools and Applications, Springer
3. Shui Qing Ye, (2008). Bioinformatics: A Practical Approach, Chapman & Hall/CRC. . Xiong, J. (2006). Essential Bioinformatics, Cambridge University Press.
4. Baxevanis, A.D. and Francis Ouellette, B. F. (2005). Bioinformatics: A Practical Guide to the Analysis of Gene and Protein. John Wiley & Sons. 3rd Ed
5. Bujnicki, J. M. (2004). Practical Bioinformatics, Springer
6. Limsoon Wong, (2004). The Practical Bioinformatician, World Scientific Publishing Co. Pre. Ltd.
7. Mount, D.W. (2004). Bioinformatics: Sequence and Genome Analysis, CBS publisher, Second Edition.

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

http://www.arguslab.com/

http://autodock.scripps.edu/

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

Course Objectives: To make the students:

i. Understand the outset of bioinformatics and its integration with diverse biological studies. The instructor will cover the strategies used to evaluate the biological facts.

ii. Impart knowledge about various principles of bioinformatics and automate the process of data analysis.

iii. Use wide variety of internet applications and biological databases to solve the problems in real research.

iv. Learn about the data generation like next generation sequencing, chemical structure drawing, microarray analysis, etc.

v. Meet the dispute of mining vast amounts of biomolecular data to discover real knowledge.

vi. Provide a critical look at some of the integration and access issues associated with several of open resources.

Course Outcomes: The learning outcomes shall make the students to:

i.	Access and browse structural data repositories to find out whether appropriate structural information exists, together with the use of structure-quality information.
ii.	Use a range of tools to perform data analyses.
iii.	Construct a structural model for a protein having a structurally characterized relative and assess its quality.
iv.	Examine the prospective impact of genetic variation on a structure.
v.	Establish the potential function of a protein based on sequence and structure data.
vi.	Gain knowledge about tools and resources for drug discovery.
vii.	Submit data to public resources for metagenomics.
viii.	Discuss the drawbacks and challenges in the field.

Teaching Methods: The mode of teaching of delivering the courses are as follows through these below mentioned methodologies:

- Delivering the lectures in the form of presentation using advanced technologies devices such as smart board.
- Video-conferencing for lectures that will be sought from experts belonging to overseas reputed institutions.
- Case-studies and Review questions

Grading System

< 50 Marks in all	50 < Marks < 59	60 < Marks < 75	Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75%

attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Scheduled dates for the various activities related to the course

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Elective: Open source in Bioinformatics (502512)

- Web based servers and softwares for genome analysis: Entrez- GenBank- GenScan-Vienna RNA Package-Biological network analysis.
- Access to protein sequence and functional information- Includes data from Swiss-Prot and TrEMBL-Database providing extensive structural and functional information for proteins-SOPMA-Predictprotein.
- Tools and resources for drug discovery: ChEMBL- drug-gene interactions, drug-protein interactions-docking-Structural visualization-RasMol- cluster genes with similar microarray expression profiles-Neural network.
- Process of primer design -standard PCR, bisulphite PCR, real-time PCR (QPCR) and sequencing. Multiple sequence alignment-TCoffee-PHYLIP-evolutionary analysis-Sequence manipulation.
- ACD Chemsketch-Drawing package-draw chemical structures including organics, organometallics, polymers, and Markush structures. Calculation of molecular properties, 2D and 3D structure cleaning and viewing-prediction of *logP*.
- Cytoscape - open source software platform for visualizing complex networks and integrating these with any type of attribute data.
- Introduction to the analysis of gene expression data obtained using microarray experiments-Basic principles.

More books for Reading and Referencing:

R Programming for Bioinformatics (Chapman & Hall/CRC Computer Science & Data Analysis) - Robert Gentleman; 2008 **(ISBN: 978-14-200-6367-7)**
Bioinformatics Research and Applications - Zhipengcai, Oliver Eulenstein, Daniel Janies and David Schwartz **(ISBN: 978-36-423-8035-8)**
Python Programming for Biology: Bioinformatics and Beyond - Tim J. Stevens and Wayne Boucher;2015 **(ISBN: 978-05-217-2009-0)**

Practical Bioinformatics (Nucleic Acids and Molecular Biology) - Janusz M. Businicki; 2007**(ISBN: 978-81-812-8522-5)**
Bioinformatics Algorithms: An Active Learning Approach (Vol. 1) - Phillip Compeau and Pavel Pevzner; 2015(**ISBN: 978-09-903-7460-2)**
Bioinformatics Algorithms: An Active Learning Approach (Vol. 2) - Phillip Compeau and Pavel Pevzner; 2014 (**ISBN: 978-09-903-7462-6)**

Code: 502512 Open source in Bioinformatics

Syllabus	Schedule
Unit-I **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.	**12 days**
Unit-II **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.	**12 days**
Unit-III **Molecular biology, Sequence alignment and Phylogeny:** NetPrimer, PerlPrimer, SimVector, CGView, BioEdit, BioCococa, Readseq, PAUP, Phylip, TreeView, Sequence Manipulation Suite, MEGA, NJplot, TCoffee, PHYML.	**10 days**
Unit-IV **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.	**10 days**
Unit-V **Chemical drawing and Microarray analysis:** ChemSketch, ChemDraw, BKChem, ScanAnalyze, Cluster, Cytoscape, dchip, SAM, DAVID Bioinformatics EASE, TM4, Pathway Explorer, Bioconductor.	**10 days**
CIA Tests, Seminars, Presentations, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar: Open source in Bioinformatics (502512)

1. DNA user.
2. RNA structure.
3. Biological Networks
4. Bio Edit.
5. Introduction to Bioubuntu.
6. Sequence Manipulation Suite.
7. Ras Mol.
8. ICM Browser.
9. Net Primer.
10. Swiss-Pdb Viewer.
11. BioInfo3D.
12. Chem Sketch.
13. Pathway Explorer.

Code: 502513 Biodiversity, Agriculture, Ecosystem, Environment and Medicine

Program: M.Sc	Semester : IV (2019-20)
Course Title & Code: **Biodiversity, Agriculture, Ecosystem, Environment and Medicine (502513)**	Class Time: Candidates are selecting the course
Name of Course Teacher	-
Mobile: -	Email : -

Course Brief

This course introduces the evolution, biodiversity, and ecology of organisms. The origin and diversity of life, from prokaryotes, through simple eukaryotes to multicellular organisms are introduced. Natural selection, speciation, and phylogeny, stressing evolutionary relationships in conjunction with changing conditions on earth, are presented. The course introduces major concepts in ecology: the physical and chemical environment, population structure, life histories, species interactions, communities, and

ecosystems. The course also introduces motivations for food and agricultural policies and presents the policy tools that can be used to meet policy goals. We will also spend time reviewing the economic theory, and introducing some new tools, that are required to analyze the effects of policy interventions. The course provides details on specific polices, with emphasis on food and agricultural policies. In addition the course illustrates major ways in which the environment and human health. Also it portrays ways that scientific studies determine the quantitative relationship between environmental parameters and health. It depicts ways that the health impact from major environmental hazards can be effectively controlled.

Reference/Text Books:

Text Books:

1. Tandon, P., Abrol, Y.P. and Kumaria, S. (2007). Biodiversity and its Significance. I. K. International Publishing House Pvt. Ltd, New delhi.
2. Singh, J.S., Singh, S.P. and Gupta, S.R. (2006). Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.

Reference Books:

1. Saha., T.K. (2013). Ecology and Environmental Biology. Books & Allied (P) Ltd.
2. Dahiya., P, Ahlawat, M. (2013). Environmental Science: A New Approach. Alpha Science.
3. Raven, P.H., Berg,L.R. and Hassenzahl, D.M. (2012). Environment. John Wiley & .Sons, Inc. Eight Edition
4. Harke., S, Pande., B.N. and Diwan., A.D. (2010). Environmental Biotechnology and Sustainable Biodiversity. Narendra Publishing House, First edition.
5. Fulekar, M. (2009). Bioinformatics: applications in life and environmental sciences. Springer Science & Business Media, Berlin.
6. Sanyal., K., Kundu., M. and Rana., S. (2009). Ecology and Environment. Books & Allied (P) Ltd.
7. Buehler, L.K., Rashidi, H.H. (2005). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press, Second Edition.

8. Arvind., K. (2004). Environment and Health. APH Publishing Corporation. First Edition.
9. Gaston., K.J. & Spicer., J.I. (2004). Biodiversity: An Introduction. Blackwell Science Ltd, Second edition
10. Krishnamurthy, K.V. (2003). An advanced Textbook on Biodiversity – principle and practice. Oxford & IBH publishing Co. Pvt. Ltd. First Edition.
11. Evans., G.M & Furlong., J.C. (2003). Environmental Biotechnology: Theory and Applications. John Wiley & Sons, Inc.
12. Yu., M.H. (2001). Environmental toxicology: impacts of environmental toxicants on living systems. Lewis Publishers, London.
13. Kresina., T.F. (2001). An Introduction to Molecular Medicine and Gene Therapy. John Wiley & Sons, Inc.

Course Objectives: To make the students

i. Analyze the environment as a determinant of health, identify and analyze current environmental health problems and issues.

ii. Explain the social-scientific basis and process for developing natural resources and environmental health policies and management practices.

iii. Evaluate and frame model environmental management systems, environmental health plan and natural resources management plan

iv. Interpret and apply environmental and natural resources policies and management principles/approaches to a variety of case-specific environmental health problems.

v. Synthesize and evaluate current environmental and natural resources management practices, policies and regulatory regimes aimed at promoting environmental public health, and recommend alternative policy and management models

vi. Develop an understanding of learning and knowledge and how theories of learning inform practice in medical teaching.

vii. Demonstrate an understanding of a range of appropriate teaching methods within medical education.

viii. Develop an understanding of assessment, curriculum design, and evaluation and feedback methods within medical education.

ix. Demonstrate the skills of critical analysis of educational research.

x. Demonstrate a solid understanding of the global sources of agricultural information such as production, yield and trade and how sustainability performance is quantified and translated into financial and economic performance.

xi. Understand how the global agriculture industry poses a great risk to sustainability but also a great investment opportunity across asset classes. Demonstrate an ability to evaluate, quantify and assess the sustainability of agribusinesses.

xii. Demonstrate an understanding of how integrating sustainability principles and practices into agribusiness and can be used to make a business become more efficient, effective, reduce risks, create opportunities and provide competitive advantage, for companies.

Course Outcomes The students shall be able to

i. Describe major social, cultural, and bio-behavioral patterns of health and health behavior in community settings.
ii. Explain causes and consequences of leading health behaviors, including tobacco exposure, dietary patterns, physical activity, alcohol consumption, and sexual practices.
iii. Illustrate major theories of health and social behavior, e.g., social learning theory and stages-of-change model, and their application in the conduct of research and practice in public health.
iv. Portray basic research from epidemiology and public health on leading health conditions.
v. A good understanding of inter-relationship between climate change, environment, food security and sustainability at global and regional (India) level.
vi. To understand the concept of food security and issues in achieving it.
vii. Understand ways of adapting to climate change and managing the environment keeping in mind food security and sustainability.
viii. Students can explain fundamental principles of evolutionary theory, and then use this knowledge to explore the evolution of biodiversity on earth.
ix. By the end of the course, students will be familiar with the major groups of organisms, including when they arrived on earth and how they are related to one another. Students will also learn basic ecological theory and begin to use these principles in understanding and proposing solutions to the major environmental problems facing the biosphere.

Teaching methods

The teaching includes lectures, discussions, demonstrations, concept maps and models, self-study and question times and an integrating project work. The project work is

in-depth studies in groups with an emphasis on own work and literature studies. The course is completed with a written final examination.

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, reviews, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 3 hour test for 75 marks and then is converted to 15 marks	Assignments, Reviews and Seminars for 10 Marks	Three Hour examination for 75 Marks.

Attendance: Having good attendance record marks the student's sincerity and has an overall positive impact on his/her personality trait development. The students are asked to attend the classes on a regular note and those having a minimum scale of 70-75% attendance are eligible to take up the end-semester examinations as per the University norms.

Punctuality: It is the most important attribute to be followed and maintained by the student throughout his/her life which for sure will lead to the path of success. Students who arrive late by 10mins after the attendance has been taken will be marked absent unless there is a valid reason (medical/ personal emergency) at the discretion of the Head of the Department.

Class Participation: A student's overall growth and personality development is based on his/her involvement in the class not just by mere presence but rather being interactive through questioning that will lead to propagation of ideas, initiation of thought-provoking process and much more that will provide a wholesome enriched classroom experience. Therefore, students are advised to be more attentive so that they learn from one another and develop quality-based knowledge.

Submission of Assignment: Assignments are given to students with just one motive to get more quantitative and qualitative knowledge insights into the assigned topic/chapter that will lead to preparation and completion of the assignment in a constructive manner here just the knowledge provided is not merely counted but also completion prior to proposed deadline will also have a check on the student's serious consideration of the assignments.

Presentation of Seminar: Apart from the assignments the concerned instructors also allocate the students with a topic or based on their interests to present seminar that will aid

them built their confidence levels, command over English language to communicate with precision and fluently. In addition, the fellow students are encouraged to pose questions that will instigate interest and provide update in that particular topic besides the information presented helping them to prepare for their examinations that can be taken as added advantage for the students.

Preparedness: At the end of every class, the concerned instructor tells the students what will be taken in the next class using these details the students should be aware of the topics that will be covered in the upcoming lectures which actually enhance the student's capability to grasp the knowledge and concepts provided much efficiently.

Academic Dishonesty: This is an important aspect that every student should be aware of. Thus, the respective faculty members educate the students of possible means of academic malpractices (plagiarism, violation of copyrights and stealing the patented knowledge) and the following consequences that will make them more vigilant in their academic career.

Subject to change clause: Based on the requirement of student's feasibility and meeting the competitive demands of the discipline the syllabus courses will be re-structured and updated accordingly at the discretion of the Professor(s) and Board of studies chairman.

Important dates: Please note down the important dates and stick to the schedule

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test I	

Course Outline: Elective: Biodiversity, Agriculture, Ecosystem, Environment and Medicine (502513)

- On completion of this course students will be able to acquire knowledge about
- Biodiversity status, scope, types, monitoring and documentation. Also major drivers of biodiversity change and biodiversity management approaches.
- Information about management and communication, libraries, bibliographies, periodicals, databases and distribution of biodiversity.
- Proportional genomes of plant and model plants, insect resistance, improve nutritional quality; grow drought resistant crops in poorer soils, biodiversity of Indian medicinal plants.
- Ecosystem structure, ecosystem function, energy flow and mineral cycling. Also they acquire knowledge about primary production and decomposition; structure and function of some Indian ecosystems: terrestrial and aquatic.

- Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy.
- Biotechnological applications of microbes, antibiotic resistance, forensic analysis of microbes, the reality of bioweapon and Metagenomics.
- Fundamentals of gene therapy, Gene therapy present and future, clinical trials.
- Applications of Bioinformatics in cancer detection, Drug targets, Human genome diversity.

More books for Reading and Referencing

Occupational & Environmental Medicine: Fourth Edition (Lange Medical Books) 4th Edition 2006 Joseph LaDou; **ISBN-13: 978-0071443135**
Environment and Ecology - (UPTU) 2011 Pandey S.N; **ISBN-13: 978-9380618593**
Ecology And Environment 2005 Sharma P.D; **ISBN-13: 978-8171339051**
Agriculture at a Glance: Enchanced Competition Explorer 2012 Sharma R.K; **ISBN-13: 978-8170357643**

Elective: Biodiversity, Agriculture, Ecosystem, Environment and Medicine

Syllabus	Schedule
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.	**7 days**
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	**7 days**

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).	**7 days**
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.	**7 days**
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.	**7 days**
CIA Tests, Seminars, Presentations, Reviews, Assignments, Journal club and Career Guidance.	**5 days**

Assignment & Seminar - Biodiversity, Agriculture, Ecosystem, Environment and Medicine (502513)

i. Explain biodiversity management approaches

ii. Fundamentals of gene therapy – Explain

iii. Applications of Bioinformatics in cancer detection - Discuss

iv. Write a note on biodiversity application software

v. Illustrate ecosystem structure, function, energy flow and mineral cycling

vi. Give an account on comparative genomes of plant and model plants

vii. Elaborate primary production and decomposition; structure and function of some Indian ecosystems.

ix. Discuss Superbugs and their concept

x. Give detailed note biotechnological applications of microbes

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NON MAJOR ELECTIVES

Code: 533704 Nanotechnology and Advanced drug delivery system

Program: M.Sc.,	Semester: III (2019-20)
Course Title and Code: **Nanotechnology and Advanced drug delivery system (533704)**	Class Time: 10-1: Tuesday
Name of the Course Teacher	Dr. N. Suganthy
Mobile: +91 – 9790252506	Email: suganthy.n@gmail.com
Name of the Course Teacher	Dr. P. Boomi
Mobile: +91 – 9486031423	Email: pboomi1983@gmail.com

Course Brief:

Nanomedicine deals with the development and application of materials and devices to study biological processes and to treat disease at the level of single molecules and atoms. This exciting new field of nanotechnology and medicine is offering unique capabilities in disease diagnosis and management. This course also offers a survey of timely concepts in the rapidly emerging nanomedicine. The vision of combining diagnostics and therapeutics, now being referred to as theranostics is the area of recent research. Currently, the main use of nanoparticle medicinal products (NMP) is their conjugation or/and encapsulation with several active biomolecules for therapeutic or/and diagnostic purposes, since they can be used as drug carriers for chemotherapeutics to deliver medication directly to the tumor while sparing healthy tissue. This course will emphasize emerging nanotechnologies and biomedical applications including nanomaterials, nanoengineering and nanotechnology based drug delivery systems, nano-based imaging and diagnostic systems, nanotoxicology and translating nanomedicines into clinical investigation.

Text/ Reference Books:

Text Books:

1. Vo-Dinh Tuan (2015) "Nanotechnology in biology and medicine methods, devices and Applications" Second edition, CRC press, San Fransico.
2. V. Mishra, P. Kesharwani, M.C.I.M. Amin, A. Iyer (2017) "Nanotechnology-Based Approaches for Targeting and Delivery of Drugs and Genes" Academic Press, London.
3. D.P. Nikolelis, G.P. Nikoleli (2018) "Nanotechnology and Biosensors" Elseiver, Amsterdam.
4. S.S. Mohapatra, S. Ranjan, N. Dasgupta, R.K. Mishra (2019) "Nanocarriers for drug delivery, Nanoscience and Nanotechnology in drug delivery", Elseiver, Amsterdam.

Reference Books:

1. M. Slevin, (2012) "Current Advances in the medical application of nanotechnology", Manchester metropolitan university, Manchester, UK.
2. T. Varghese and K.M. Balakrishna, (2012) "Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials", Atlantic Publishers & Distributors
3. W.M. Jeff Bulte, and Michel M.J. Modo, (2016) "Design and Applications of Nanoparticles in Biomedical Imaging", Springer.
4. P. Kumar, R. Srivastava, (2016) "Nanomedicine for Cancer Therapy: From Chemotherapeutic to Hyperthermia-Based Therapy", Springer.
5. B. Malhotra, Md. A. Ali, (2017), "Nanomaterials for Biosensors- Fundamentals and Applications", 1st Edition, Elsevier.
6. M. Raza Shah, M. Imran, and S. Ullah, (2017) "Lipid-Based Nanocarriers for Drug Delivery and Diagnosis", William Andrew.
7. K.K. jain, (2017) "The Handbook of Nanomedicine" 3rd Edition, Publisher-Humana Press.

Weblink references

1. http://www.nanomedicinecenter.com
2. https://nptel.ac.in/courses/118107015/module4/lecture7/lecture7.pdf
3. https://nptel.ac.in/courses/102107058/
4. https://nptel.ac.in/courses/118106019/Module%209/Lecture%203/Lecture%203.pdf
5. http://www.imm.org/Reports/rep048.pdf

Course Objectives: The main objective of the course is to

1. Provide students broad overview of the application of nanotechnology to medicine

2. Impart knowledge on the role of biological and synthetic nanocarriers in drug delivery.
3. Understand the regulatory and ethical aspects on use of nanotechnology in clinical practice

Course Outcomes: On successful completion of the course the students will be able to

1. Comprehend the principles behind nanomedicine
2. Gain a broad understanding of concepts and applications of nanomedicine
3. Impart the knowledge to apply these nano-drug delivery systems for the diagnosis and therapy
4. Understand the concepts of nanomedicine to a focused clinical area of their choice

Teaching Methods: The course will be based on the following teaching and learning activities:

- Lectures covering the theoretical part using PowerPoint presentations
- Case studies
- Review questions

Grading System

< 50 Marks in all	50 < Your Marks < 59	60 < Your Marks < 75	Your Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Assessment & Evaluation: Student evaluation is based on exams, assignments, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two, 2 hour tests for 15 marks in all	Assignments and seminars for 10 Marks	Three Hour examination on the whole syllabus for 75 Marks.

Attendance: Regular attendance is necessary for gaining academic success; hence the students are expected to attend all the classes. As per University norms, the students are qualified to write their end-semester examinations only if they have a minimum attendance of 75% in all the courses.

Punctuality: Punctuality is an important quality for the students to achieve success. Students arriving late to the class by 10 minutes without any valid reason will be marked

absent in the attendance record. Excuse will be provided for personal or medical emergency with prior approval by the Head of the Department

Class Participation: Classroom participation is important because learning is not just between the student and the teacher, but part of the whole classroom experience which involves questioning, inquiring and exchanging ideas. When students participate, they learn from each other and internalize the knowledge better.

Submission of Assignment: Assignments will help the students to apply the concepts which results in deeper understanding of the subject. Hence each student will be allocated two assignments for the course, covering the entire topic. Students will be provided deadline by the course instructor to submit the assignment. Proper preparation of assignment will help the students for final exams

Presentation of Seminar: Students are supposed to give an oral presentation during the class seminar hours in their assigned topic. Students will discuss on recent research finding related to the topic and participants are encouraged to ask valid questions. Seminars help the students to be updated in their course. In addition students will be able to learn their mistakes and can improve their communication skills during seminar presentation

Preparedness: Prior to attending the class the **s**tudents are expected to collect information regarding the topic given in advance, so that they will be able to discuss during the lecture.

Academic Dishonesty: Since the students are not aware of academic integrity, students must be clearly explained about plagiarism and the consequences of violation of copyright laws, so that academic dishonesty may be avoided.

Subject to change clause: Depending upon the requirement of student, the course syllabus and course schedule are subjective to minor changes, which will be informed to students

Important dates: Scheduled dates for the various activities related to the course

CIA Test I	CIA Test II	Assignment	Seminar
As per Academic Calendar		After CIA Test-I	

Course Outline: Nanotechnology and Advanced drug delivery system (533704)

1. Properties and technological advantages of nanomaterials.
2. Top down and Bottom up approaches for the synthesis of nanomaterials.

3. Characterization of the synthesized nanomaterials by spectroscopic analysis and microscopic observations.
4. Types of nanocarriers used in drug delivery and its physicochemical properties.
5. Targeted and Non-targeted drug delivery using nanocarriers.
6. Various strategies of surface modification of Nanoparticles to enhance biocompatibility.
7. Role of Nanoparticles in diagnosis and imaging.
8. Fabrication of DNA and Protein based biosensor and its diagnostic application.
9. Theranostics nanomedicine for the treatment of cancer.
10. Nanotechnology application in the treatment of neurology, cardiology and opthamology.

More books for Reading and Referencing

Kewal K. Jain, "The Handbook of Nanomedicine", (2008), Publisher-Springer Science & Business Media, **ISBN: 1603273190, 9781603273190**
V. P. Torchilin, "Nano Particulates As Drugcarriers", (2006), Publisher-Imperial College Press, **ISBN: 186094907X, 9781860949074**
Ram B. Gupta and Uday B. Kompella "Nanoparticle Technology for Drug Delivery", (2006), Publisher-CRC Press, **ISBN: 0849374553, 9780849374555**
R. Khare, "Nanomedicine and Future drugs", (2015), **ISBN:9384568643, 9789384568641**
Mark Slevin, "Current Advances in the medical application of nanotechnology" (2012), Publisher- Bentham Science Publishers, **ISBN: 1608051315, 9781608051311**
T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", (2003), Publisher-Tata McGraw-Hill Education, **ISBN: 1259007324, 9781259007323**
Mansoor M. Amiji, "Nanotechnology for cancer therapy", (2006), Pubisher-CRC Press, **ISBN: 1420006630, 9781420006636**
Jeff W.M. Bulte and Michel M.J. Modo, "Nanoparticles in Biomedical Imaging Emerging Technologies and Applications", (2007), Publisher- Springer Science & Business Media, **ISBN: 0387720278, 9780387720272**

Nanotechnology and Advanced drug delivery System (2 credits)

Syllabus	Schedule

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.	**2 days**
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.	**3 days**
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.	**3 days**
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.	**3 days**
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 -	**2 days**

Nano-Orthopedics - Nano-Ophthalmology.	
8 days left for CIA Tests	

Assignment I Nanotechnology and Advanced drug delivery system (533704)

1. Discuss in detail the top down and Bottom up approach of synthesis of Nanomaterials.
2. Give an account on synthesis, properties and biomedical application of quantum dots.
3. Explain in detail the various spectroscopic techniques used for the characterization of metal nanoparticles with suitable example.
4. Elaborate in detail the sample preparation and working principle behind the characterization of nanoparticles using TEM with a neat sketch.
5. Describe in detail principle and instrumentation of XRD technique and its application in the characterization of metal and metal oxide nanoparticles.
6. Elaborate in detail the types and application of polymeric nanocarriers in targeted drug delivery.
7. Explain in detail about viral nanocarriers and its application.
8. Discuss in detail the about functionalization and pharmacological application of carbon nanotubes.
9. Give an account on microbial nanocarriers and its application in the treatment of cancer.
10. Discuss in detail the various methods of surface modification of mesoporous silica nanoparticles for cancer therapy.

Assignment II Nanotechnology and Advanced drug delivery system

1. Discuss in detail about physiochemical properties of drug molecule influencing the design and performance of sustained release drug delivery system.
2. Explain with examples biodegradable and non biodegradable polymers used for controlled drug delivery system.
3. Give an account of approaches and applications of implantable drug delivery systems.
4. Describe in detail the active and passive targeting in drug delivery.
5. Elaborate in detail the surface modification techniques to enhance the biocompatibility of drug.

6. Discuss in detail about liposomal drug delivery system in drug targeting to a specific site.
7. Discuss in detail the role of Quantum dots in live cell imaging and diagnostics.
8. Describe in detail the principle and application of DNA and Protein based biosensors.
9. Discuss about the theranostic application and targeted drug delivery of nanoparticle for the treatment of cancer.
10. Elaborate in detail the role of nanomaterials in the field of orthopedics as bone implants and for the treatment of joint injuries involving cartilage.

Code: 509203 Immunology and Immunotechnology

Program: M.Sc Bioinformatics	Semester : II (2019-20)
Course Title: Core- Immunology and Immunotechnology (509203)	Class Time: 10-1: Tuesday
Name of Course Teacher	Dr. B. Vaseeharan
Mobile: 9894720893	Email : vaseeharanb@gmail.com

Course Brief:

This course provides an introduction to the basic immunological principles common to man and other vertebrate animals. It provides information related to immunity, development of resistance against infection, mechanisms of antigen and antibody reaction, antigen processing and presentation to macrophages cells. This course also provides basic techniques in immunology such as ELISA, RIA, immunofluorescence microscopy, immunoelectrophoresis, immunodiffusion and hybridoma technology. The laboratory component of the course is designed in such a way to strengthen the technical knowledge of the students and to physically train them with state of art technology. This course would definitely assist the students to gain more knowledge on immunotechniques.

Reference/Text Books

Text Books:

1. Kannan I., (2012) "Immunology"; MJP Publishers, 5th Edition.

2. B. Annadurai., (2017) A Textbook of Immunology & Immunotechnology, S Chand & Company, ASIN: B00QUZMCI2.

Reference Books:

1. Ivan M. Roit and Pete J. Delves., (2011) "Essential Immunology"; Blackwell Science, 12th Edition.
2. Kuby, Judith A. Owen, Jenni Punt and Sharon A. Stranford (2013) "Immunology"; Freeman W.H. and Company, 7th Edition.
3. Owen, J., Jenni Punt, Sharon Stranford (2013). Kuby Immunology W. H. Freeman; 7th edition.
4. K Sai Leela, SK Mohanty, (2013) "Textbook of Immunology"; 2nd Edition, ISBN-13: 978-9350908518.
5. Warren Levinson, (2016) "Review of Medical Microbiology and Immunology"; McGraw-Hill Education, Fourteenth Edition, ISBN-13: 978-0071845748.
6. Vaman Rao., (2016) "Immunolog**y";** Narosa Publishing House Pvt, Ltd 3rd Edition.
7. Abdul.K. Abbas, Andrew. H. Lichtman, Shiv Pillai, (2017) "Cellular and Molecular Immunology"; Elsevier Publisher, 9th Edition.

Course Objectives:

The course objectives include

➢ To study the basic immunological principles common to man and other vertebrate animals.
➢ To study the types of immunity, immune organs and immune response to diseases. To acquire practical skills in immunotechniques such as ELISA, RIA, Immunoelectrophoresis, Immunodiffusion and hybridoma technology
➢ To know the types of antigens, antibodies and processing of antigen by immune cells.

Course Outcomes: After completion of this course, the students will be able to describe, identify, and/or explain:

➢ Students will be able to describe the cell mediated and humoral immunity and the role of lymphoid organs in the differentiation and maturation of T and B lymphocytes.
➢ Students will be able to explain the types of antigens and antibodies. The mechanism of antigen and antibody reaction including agglutination and

opsonization.
➢ Students will be able to describe the hypersensitivity types, immunodeficiency diseases and role of major histocompatibility complex in transplantation reaction.

Assessment & Evaluation: Student evaluation is based on CIA exams, assignments, seminars and class participation. The grade allocation is as follows:

Continuous Internal Assessment : 25 Marks		**End-Semester Exam: 75 Marks**
Two CIA, 3 hour tests for 75 marks converted into Average 10 Marks	Assignments-5, Seminars-5, Attendance-5	Three Hour examination on the whole syllabus for 75 Marks.

Grading System

< 50 Marks in all	50 < Marks < 59	60 < Marks < 75	Marks ≥ 75
Reappear	**II Class**	**I Class**	**Distinction**

Attendance: Attendance and participation are vital to the student's success in this course. Students are expected to attend class every day. Minimum attendance to be eligible to take end-semester-examination is 80%. It is also essential that the students study regularly.

Punctuality: Punctuality is very important in the course, because if student are late, you not only waste your time, but other student's. You will also disturb others when you go into the lecture class or laboratory after the class begins. Therefore, please arrive at the class on time. Names of late students will be recorded by mentor and marks from Course performance will be deducted. An excuse for being absent from class shall be a medical or personal emergency acceptable at the discretion of the Head of the Dept.

Class Participation: Class participation and interaction helps to form a complete educational experience. However, class participation and interaction is to be relevant to course content and context. Deviant behavior may lead to dismissal or suspension.

Submission of Assignment: Short writing assignments that address the various topics covered will be given at various times throughout the course. These writing assignments may consist of worksheets, short handwritten problems/questions, or short written assignments. The purpose of these short assignments are double they will help determine

which concepts students may be having trouble with and it will help keep actively engaged in the material as we cover it.

Preparedness: Students are expected to have read and be able to discuss the assigned chapter before attending the lecture. In addition, students should be prepared to discuss homework problems.

Academic Dishonesty: Academic dishonesty includes giving, receiving, or using unconstitutional support on any academic work. This includes a person who has taken a test discussing what was on a test with a person who has not taken the test. A clear indication of academic dishonesty will result in a grade of "F" being assigned to that particular piece of work.

Subject to change clause: This syllabus, the course schedule and reading assignments are subject to change at the discretion of the Professor to accommodate instructional and/or student needs.

Components of Internal Assessment (Max. Marks 25)

Assignment/Seminar-I	CIA Test-I	Assignment/Seminar-II	II CIA Test	Attendance
During the course of hours	As per Calendar	During the course of hours	As per Calendar	As per the University Norms

Course Outline: Elective-II: Immunology and Immunotechnology (509203)

1. Introduction and scope of immunology
2. Innate and adaptive immunity
3. Elements of immune system
4. Immune response, immunoprophylaxsis
5. Vaccination and immunization schedule
6. Hypersensitivity, immunodeficiency diseases
7. Major histocompatibility complex and immunotherapy
8. Immunocytochemistry, Imunoflourescence, Immunoelectrophoresis,Immunodiffusion
9. ELISA, RIA, flowcytometry, AIDS, hybridoma technology
10. Glossary

Elective: Immunology and Immunotechnology (2 Credits)

Syllabus	Schedule 4hrs/week
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.	**10 days**
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.	**20 days**
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.	**20 days**
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.	**10 days**
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.	**10 days**
Internal test and Department activities	**10 days**
8-10 days left for CIA Tests, Quizzes, Seminars, group discussions, etc.	

Assignment I Lymphoid organs (509203)

1. Lymphiod organs and its types
2. Types of immunity
3. Immunodeficiency diseases
4. Major histocompatibility complex
5. Immunocytochemistry

Assignment II Immune system

1. Types and functions of antibodies
2. Cytotoxicity
3. Immunoprophylaxis
4. Autoimmune disorder

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