# SOLAPUR UNIVERSITY, SOLAPUR
# M. Sc. –II- BIOINFORMATICS
# SYLLABUS
## (CHOICE BASED CREDIT SYSTEM)
## (w.e.f. June-2016-17)

The syllabus of M.Sc. – Bioinformatics course of two years duration has been prepared as per the Choice based credit system (C.B.C.S.). M. Sc. II syllabus is to be implemented from June 2016. The syllabus of M. Sc. Part I was implemented with effect from June 2015. The syllabus has been prepared taking into consideration the UGC guidelines, SET, NET examination syllabus, the syllabus of other universities and the specific inputs of the Expert Committee Members.

**General Structure of the Course:** The course will be of four semesters spread over two academic years. Each semester will have four theory papers of 70 marks each for University External Examination and 30 marks each for Internal Examination and two practical courses of 70 marks each for University External Examination and 30 marks each for Internal practical course. The distribution of marks is as mentioned below.

| | | |
|---|---|---|
| Theory Paper (Semester Exam), | 16 X (70+30) marks | 1600 marks |
| Practical's (Semester End Exam.), | 8 X (70+30) marks | 800 marks |
| Seminars for each Semester, | 4 X (25 Marks) | 100 marks |
| | | ---------- |
| | | **Total: 2500 marks** |

## SEMESTER-I

| Theory Paper No. | Title of Theory Paper | Marks | | | Credits |
|---|---|---|---|---|---|
| | | UA | CA | Total | |
| I | Basic Bioinformatics | 70 | 30 | 100 | 4 |
| II | Cell Biology and Genetics | 70 | 30 | 100 | 4 |
| III | Introduction to HTML and Biostatistics | 70 | 30 | 100 | 4 |
| IV | Introduction to Programming languages & programming through C & C++ | 70 | 30 | 100 | 4 |
| **Practical Course No.** | **Title of Practical Course** | **Marks** | | | **Credits** |
| | | **UA** | **CA** | **Total** | |
| I | Basic Bioinformatics and Cell Biology and Genetics | 70 | 30 | 100 | 4 |
| II | Introduction to HTML and Biostatistics and Introduction to Programming languages & programming through C & C++ | 70 | 30 | 100 | 4 |
| | Seminar – I | -- | 25 | 25 | 1 |
| | | | | **625** | **25** |

## SEMESTER-II

| Theory Paper No. | Title of Theory Paper | Marks | | | Credits |
|---|---|---|---|---|---|
| | | UA | CA | Total | |
| V | Advanced Bioinformatics | 70 | 30 | 100 | 4 |
| VI | Microbiology and Biotechnology | 70 | 30 | 100 | 4 |
| VII | Basic Biochemistry and Immunology | 70 | 30 | 100 | 4 |
| VIII | Programming in Object Oriented languages | 70 | 30 | 100 | 4 |
| **Practical Course No.** | **Title of Practical Course** | **Marks** | | | **Credits** |
| | | **UA** | **CA** | **Total** | |
| III | Advanced Bioinformatics and Microbiology and Biotechnology | 70 | 30 | 100 | 4 |
| IV | Basic Biochemistry and Immunology and Programming in Object Oriented languages. | 70 | 30 | 100 | 4 |
| | Seminar – II | -- | 25 | 25 | 1 |
| | | | | **625** | **25** |

**Practical Course**: (Semester End Examination) Practical Paper - I to IV for semester I and II. Practical Examination will be of 4 days (per day per subject) for each semester

## SEMESTER-III

| Theory Paper No. | TITLE OF THEORY PAPER | Marks | | | Credits |
|---|---|---|---|---|---|
| | | UA | CA | Total | |
| IX | Biological Database Management System | 70 | 30 | 100 | 4 |
| X | Advanced Biophysical Techniques | 70 | 30 | 100 | 4 |
| XI | Computational Structure Biology and Drug designing | 70 | 30 | 100 | 4 |
| XII* **ELECTIVE** | A) Research Methodology and IPR in Bioinformatics<br>OR<br>B) Advanced Pharmaceutics | 70 | 30 | 100 | 4 |
| **Practical Course No.** | **TITLE OF PRACTICAL COURSE** | **Marks** | | | **Credits** |
| | | **UA** | **CA** | **Total** | |
| V | Biological Database Management System | 35 | 15 | 50 | 2 |
| VI | Advanced Biophysical Techniques | 35 | 15 | 50 | 2 |
| VII | Computational Structure Biology and Drug designing | 35 | 15 | 50 | 2 |
| VIII* **ELECTIVE** | A) Research Methodology and IPR in Bioinformatics<br>OR<br>B)Advance Pharmaceuticals | 35 | 15 | 50 | 2 |
| | Seminar – III | -- | 25 | 25 | 1 |
| | | | | | |
| | | | | **625** | **25** |

*Theory Paper - XII is offered as an elective under CBCS to the students.

## SEMESTER-IV

| Theory Paper No. | TITLE OF THEORY PAPER | Marks | | | Credits |
|---|---|---|---|---|---|
| | | UA | CA | Total | |
| XIII | Biological Simulation and modeling | 70 | 30 | 100 | 4 |
| XIV | Clinical Bioinformatics | 70 | 30 | 100 | 4 |
| XV | Advanced Molecular biology | 70 | 30 | 100 | 4 |
| XVI* **ELECTIVE** | A) Emerging Areas of Bioinformatics<br>OR<br>B) Molecular Medicine | 70 | 30 | 100 | 4 |
| **Practical Course No.** | **TITLE OF PRACTICAL COURSE** | **Marks** | | | **Credits** |
| | | **UA** | **CA** | **Total** | |
| IX | Biological Simulation and modeling & Clinical Bioinformatics and Advanced Molecular biology | 70 | 30 | 100 | 4 |
| X* **ELECTIVE** | A) Emerging Areas of Bioinformatics<br>OR<br>B) Molecular Medicine | 35 | 15 | 50 | 2 |
| XI** | Project Dissertation and Viva Voce | 35 | 15 | 50 | 2 |
| | Seminar | -- | 25 | 25 | 1 |
| | | | | **625** | **25** |

*Theory Paper –XVI is offered as an elective under CBCS to the students.

*Practical Paper – VIII & X are offered as elective under CBCS to the students

** Practical - XI – Project work has to be done by individual student. It may be in-house project including inter department/programme or projects in organizations outside the institution i.e. in Research Laboratories / Industry / other agencies

**Practical Course (SEM-III)**: (Semester End Examination) Practical Papers – V to VIII for semester III Practical Examination will be of 4 days (per day per subject).

**Practical Course (SEM-IV)**: (Semester End Examination) Practical Papers – IX will be of 2 days, Practical Paper -X will be of 1 day and Practical Paper -XI will be of 1 day.

**SUMMARY**

| Course | No. of Papers | Total marks | Examination Pattern | | Total Credits |
|---|---|---|---|---|---|
| | | | UA | CA | |
| Core | 14 | 1400 | 980 | 420 | 56 |
| Elective | 04 (any two) | 200 | 140 | 60 | 08 |
| Practical Course | 08 | 800 | 560 | 240 | 32 |
| Seminars | 04 | 100 | - | 100 | 04 |
| **TOTAL** | | **2500** | **1680** | **820** | **100** |

**Nature of Examination**: Each semester will have theory University external examination of four papers of 70 marks each (2 and 1/2 hrs. duration). The practical examination of Semesters I to IV will be conducted at the end of the each Semester. Duly certified copy of laboratory record must be produced at the time of examination.

Practical Examination of M. Sc. II The practical examination will be of 4 days for each semester. There will be 70 marks University external practical examination while 30 marks internal examination. The distribution of marks for each Practical paper -V, VI, VII, VIII and IX will be of 70 marks and Semester IV Practical paper-X & elective will be of 50 marks Project work and its report of 50 marks will be included in Practical paper -XI whereas distribution of marks for Practical paper -XI will be below:
The report shall be examined by the Examiners (appointed by the University) who will assign marks out of 35 for project work as follows:

1) Selection of the project topic - 2 marks
2) Literature review - 2 marks
3) Objectives - 2 marks
4) Experimental Design - 5 marks
5) Result and Discussion - 2 marks
6) Conclusion and findings - 2 marks
7) Report Writing - 10 marks
8) Oral presentation and Viva - 10 marks

**Total: 35 marks**

** The valuation to be done by both external and internal examiners at the time of Practical paper V to XI practical examination. Valuation of Seminars is to be done by Departmental Faculty involved in Bioinformatics.

**Nature of Theory question paper for each theory paper.**

**SOLAPUR UNIVERSITY, SOLAPUR**
**Nature of Question Paper for Semester Pattern**
**(New CBCS)**
**M.Sc. Bioinformatics**

**Time:- 3 hrs** **Total Marks-70**

**Note: 1) Section - I Compulsory**
**2) Answer any four questions from Section - II**

**Section - I**

**Q. 1 A)** Multiple choice questions **(07)**

i) ----------

a) b) c) d)

ii)

iii)

iv)

v)

vi)

vii)

**B)** Define the following terms **(07)**

i)

ii)

iii)

iv)

v)

vi)

vii)

**Section - II**

**Q. 2)** Long answer type question **(14)**

**Q. 3)** Long answer type question **(14)**

**Q. 4)** Long answer type question **(14)**

**Q. 5)** Answer any *TWO* of the following **(14)**

i) Short answer type question

ii) Short answer type question

iii) Short answer type question

**Q. 6)** Write Short notes on any *TWO* of the following **(14)**

i) Short note

ii) Short note

iii) Short note

N.B. In Q.5 and 6 the sub-questions (i, ii, and iii) in a given question should be from different topics of the syllabus.

At least 25 % questions should be problem oriented, where-ever possible, in view to train students for the SET/NET/GATE and other competitive examinations. These questions should test the understanding of candidate rather than the memory. The question paper should cover all the Units included in the syllabus of the respective paper and the weightage of the questions should correspond to the number of lectures allotted to the respective Units / Topics.

## M. Sc. BIOINFORMATICS SYLLABUS

## SEMESTER- III

### Paper-IX: BIOLOGICAL DATABASE MANAGEMENT SYSTEM (45L-4 Credits)

**Unit-I: Introduction to DBMS Architecture:** Database – Definition, Limitations of traditional file processing systems, Advantages of DBMS, Users of DBMS. Database Architecture and Environment: Components of DBMS, Architecture, Physical, logical and view, DDL, DML, DCL, schemas, life cycle of Database System Development, Functions of DBMS. Conceptual Database Modeling: Data Model – Concept, types of data models, ER model, concepts of entity, entity set, attributes, domains, existence dependency, Keys: candidate, primary, composite, strong and weak entities, cardinality, specialization, generalization, aggregation, Relational Algebra, Relational calculus. **(10)**

**Unit-II: Data mining:** An overview of Data mining technology, classifications, clustering, data warehousing, Applications of Data mining, Access to Molecular biology data bases: Entrez, ExPASy, Protein Identification Resources (PIR) and Bibliographic databases. **(5)**

**Unit-III: Data Normalization for RDBMS:** Introduction to RDBMS, Relational model concept, characteristics of relations, entity integrity, relational integrity and keys. Introduction, design, guidelines for relational schemes, semantic of attributes, Introduction to Normalization 1NF, 2NF, 3NF, BCNF, Introduction to relational algebra & calculus. **(12)**

**Unit-IV: Overview of Oracle:** Objectives, Introduction, Database Management Tools, The data dictionary, DBA, The utilities. Structures in Oracle, Physical structure, Data files, Control files, Logical structure. Introduction to SQL, Objectives, SQL Select Statements, Data Manipulation Statement, Data Definition Statements, Data Control Statements, Data query language, Basic SQL queries, more complex SQL queries, Join operation, views in SQL. **(10)**

**Unit -V: Basics of PL-SQL:** Introduction to PL-SQL, Features of PL/SQL, advantages of PL/SQL, PL/SQL Program structure, PL/SQL Program Units (Anonymous blocks, procedures, functions, packages, triggers). Comments in PLSQL, Data types if PLSQL, Exception Handling. **(8)**

**References:**


1.Database System Concepts by Hanery Korth and Abraham Silberschatz, Tata Mac-Graw Hill.
2. An Introduction to Database Systems by C.J. Date, Addison-Wesley.
3. Database system organization by J.M. Martin, Princeton-Hall.
4. Introduction to Database systems byJ.M. Martin; Princeton-Hall.
5. ORACLE: Power Objects Handbook by Bruce Kolste, David Peterson.
6. Oracle 8 SQL Programming and Tuning by P. Cassidy, 1998.
7. SQL, PL/SQL: the programming language of oracle by I. Bayross, Ed. 2, New Delhi. BPB Publications, 2002.

8. Oracle SQL & PL/SQL Handbook: a guide for dataadministrators, developers, and business Analysis (With CD) by J. Palinski,Delhi, Pearson Education, 2003.
9. Wiederhold, Database Design. McGraw Hill.
10. Miers, Relation Database. Computer Science Press.
11. The Complete Reference of PL-SQL, McGraw Hill.

**PAPER-X: ADVANCED BIOPHYSICAL TECHNIQUES (45L-4 Credits)**

**Unit-I: Fundamentals of chemical bonding and non-bonding interactions:** Electrovalent bond, stability of electrovalent bond. Covalent bond–partial ionic character of co-valent bonds. Shape of orbitals and hybridization. Co-ordination bond, Vander Waals forces; Metallic bond and Electron density map and its interpretation. **(10)**

**Unit-II: Spectroscopy:** Principles, Theory, Instrumentation and Application of UV-Visible, IR, FTIR, CD and ORD to macromolecules, Mass spectrometry; Introduction, different methods of ionization, MALDI-TOF, Analysis and application. NMR; Principles, theory, instrumentation and application. **(15)**

**Unit-III: Lasers:** Introduction, basic working principle of lasers, types of lasers, importance and applications of lasers in biological studies (treatment and analysis). **(5)**

**Unit-IV: X-ray crystallography:** Early scientific history of crystals and X-rays, Principles, Theory, Instrumentation, Properties, sources of X-radiation, Application of X-rays to biology and medicine (diagnosis and molecular structure studies.). **(5)**

**Unit-V: Microscopy:** Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Fluorescent Microscopy and Confocal Microscopy, Infra Red Microscopy and Raman Microscopy. **(10)**

**References:**


1. Spice, J. E. 1964. Chemical Bonding and Structure. Pergamon Press Ltd., Headington Hill Hall, Oxford. 395 pp.
2. Jan Drenth Principles of Protein X-ray Crystallography (Springer Advanced Texts in Chemistry), Springer-Verlag Telos.
3. Lipson, H. and Steeple, H., Interpretation of X-Ray Powder Diffraction Patterns. St. Martin's Press.
4. Bovey, F,A., Mirau, P.A. and Gutowsky, H.S., Nuclear Magnetic Resonance Spectroscopy (2nd Edition). Academic Press.
5. Hallet, F.R., Stinson, R.H., Speight, P.A. and Graham, W.G., 2004 Physics for the Biological Science, Toronto: Nelson Can.
6. Yadav, L.D.S., Organic Spectroscopy (1st Edition). Springer.
7. Hollas, J.M., High Resolution Spectro scopy (2nd Edition). John Wiley & Sons.

**PAPER-XI: COMPUTATIONAL STRUCTURE BIOLOGY AND DRUG DESIGNING**

**(45L-4 Credits)**

**Unit -I: Introduction to Structural and Pathway Databases:** structural data, exploring the structural databases such as Protein Data Bank (PDB) at RCSB, Catalytic Site Atlas (CSA), Homology Derived Structures of Proteins (HSSP), Protein Data Bank Europe (PDBe), PDBeChem, PDBeFold, PDBeMotiff, PDBeNMR, PDBSum, SCOP and CATH. Introduction to biological Pathway Databases. **(9)**

**Unit -II: Structure Prediction Methods:** Statistical methods of Chou-Fasman, Garnier-Osguthorpe- Robson method, Neural network method, Position specific scoring matrices, Motifs and domains, folds and protein folding. **(9)**

**Unit -III: Homology Modeling:** Introduction to homology modeling, Fold recognition and Threading, RNA structure prediction, architectures and topologies of protein and DNA using molecular visualization software, Structure validation. **(6)**

**Unit -IV: Molecular interaction:** Molecular interaction; protein-protein, protein-DNA, Protein-Lipid, Protein- Ligand, Protein-Carbohydrate, DNA-Drug interaction, Metalloproteins, Pi … Pi interactions, C-H…Pi interactions. **(6)**

**Unit -V: Drug Discovery and Drug designing:** Natural products, drugs, principles of drug development, Drug discovery, mutation in drug targets, automated drug design, structure based and ligand based drug design methods, combinatorial chemistry, high throughput screening (HTS), *in silico* ADMET properties, QSAR, developing lead library, DOCKING; introduction to docking method to generate new structure, tools and molecular docking programs-AUTODOCK, HEX and VLifeMD suite, virtual screening, Drug metabolism; Cytochrome p450, pharmacodynamics and pharmacokinetics, clinical trials, FDA approval. **(15)**

**References:**


1. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997
2. Proteome Research: New Frontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
3. Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Second Edition, Wiley.
4. Graur, D. and Li, W-H. 2000 Fundamentals of Molecular Evolution. Sinauer Ass.,USA.
5. Essential Bioinformatics, Jin Xiong
6. Rastogi S. C., Mendiratta. N., Rastogi. P. 2005 Bioinformatics methods and application, Genomics, Proteomics, and Drug Discovery.

**OPEN ELECTIVE**

**PAPER-XII: (A) RESEARCH METHODOLOGY AND IPR (45L-4 Credits)**

**Unit-I: Research:** Definition, Importance and Meaning of Research, Objectives of research, Characteristics of Research, Types of Research. Steps in Research; Identification, Selection and Formulation of Research Problem, Research Questions, Research Design, Formulation of Hypothesis, Review of Literature. Problems encountered by researchers in India. **(15)**

**Unit-II: Scientific report writing:** Introduction to Scientific papers and Journals, computer and internet application in Research. Preparation of Manuscript; Author instructions, Methodology, modes of paper communication, criteria for publication. Thesis writing: Abstract, Introduction, Review of Literature, Materials and Methods, Results and Discussion, Summary and Conclusion and References. Presentation of a scientific Paper / Document: Preparation of Oral Presentation and Poster Presentation for conferences. Use of Audio-Visual aids in Presentation. **(10)**

**Unit-III: Parametric Tests:** Testing of significance Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Co efficient. Chi-square tests, ANOVA One way and two ways. Research Report: Types of Reports, Styles of reporting, Steps in drafting reports, editing the final draft, evaluating the final draft. **(5)**

**Unit-IV: Introduction to IPR and Patents:** Intellectual property, Protection of Intellectual property, World intellectual property organizations, Forms of protection- patent, copyright, trademark, trade secrets, geographical indications,. Criteria and procedure of patenting, patenting biological material. Patent procedure in India. Types of patenting, Patenting of biological materials with examples and case studies. **(10)**

**Unit-V: Plant breeder's right:** UPOV, Breeders exemption, Plant variety protection in India. Farmer's right, advantages and disadvantages of PBR. Technology transfer- Introduction, types of technology transfer and Indian scenario. **(5)**

**References:**

1. Statistical Methods by S.P. Gupta.
2. Research Methodology, Method and Techniquesby C.R. Kothari or by Santosh Gupta.
3. Research Methodology by Gurumani.
4. Introduction to Biotechnology by B. D. Singh.

**OPEN ELECTIVE**

**PAPER-XII: (B) ADVANCE PHARMACEUTICALS (45L-4 Credits)**

**Unit-I: Introduction to Advance Pharmaceuticals:** Solids: Particle characterization by size, shape and surface of individual particle and for contacted particle. Handling of solids, pharmaceutical granulation, compression and compaction properties of binary mixtures, lubricant sensitivity, characterization of granules and compacts. . **(08)**

**Unit II: Dissolution:** Theory of dissolution, concept of drug release. Dissolution test apparatus: different designs, factors affecting dissolution rate. Dissolution of different dosage forms: solids, suspensions, topicals, suppositories and controlled release systems. Enhancement of dissolution rate. Solid dispersions: Types, methods of preparation, selection of carrier, characterization and applications. **(10)**

**Unit-III: Surfactant System:** Phase behaviour of surfactant in binary and ternary systems. Factors affecting phase behaviour; Micellization; micelle structure, shape, size factors affecting CMC and micelle size, thermodynamics and kinetics of micelle formation. Pharmaceutical aspects of Solubilization, Solubilization in non-aqueous system, interactions with polymers and oppositely charged species. Hydrotrophy in pharmaceuticals, surfactants in emulsions and suspensions. Biological implications of surfactants; Effect on: dissolution of drugs, permeability of membranes, drug absorption, antibacterial activity. Cyclodextrin inclusion complexes and co-solvents. (**12)**

**Unit-IV: Polymer science:** Types and applications of polymers, polymerization reactions, methods of polymerization and characterization of polymers, thermodynamics of polymer solutions. (**05)**

**Unit-V: Stability studies:** Kinetics activation energy calculations, accelerated stability studies, factors responsible for destabilization of pharmaceutical products and techniques to improve, shelf life calculations. Physical testing of solution, suspension, emulsion, aerosol, powder, tablet and sustained release products. **(10)**

**References:**


1. Kitahard and A. Watanabe; Electrical Phenomena at Interfaces; Marcel Dekker.
2. Martin, P. Bustamante and A. H. Chun; Physical Pharmacy; Waverly.
3. D. M. Parikh; Handbook of Pharmaceutical Granulation Technology; Marcel Dekker.
4. G. Alderborn and C. Nystrom; Pharmaceutical Powder Compaction Technology; Marcel Dekker.
5. H. G. Brittain; Physical Characterization of Pharmaceutical solids; Marcel Dekker.
6. J. T. Cartensen; Drug Stability; Marcel Dekker.
7. James J. Wells; Pharmaceutical Preformulation, Ellis Harwood Ltd.
8. Lieberman, Rieser and Banker; Pharmaceutical Dosage Forms; Disperse system; Marcel Dekker.
9. M. N. Rubinstein; Pharmaceutical Technology, Drug stability, John Wiley and sons.
10. Martin Rhodes; Principles of Powder Technology, John Wiley and sons.
11. N. G. Stanley – Wooed; Enlargement and compaction of particle solids; Butterworths.

12. P. H. List and P. C. Schmidt; Pharmaceutical Technology, CRS Press.
13. P. J. Tarcha; Polymer for Controlled Drug Delivery, CRC Press.
14. Robinson; Novel Drug Delivery Systems, Marcel Dekker.

**PRACTICAL PAPER-V: Biological Database Management System (45L-4 Credits)**

1. Practical based on DDL statements create table, modify table structure, drop table, rename table
2. Practical based on "Data Manipulation Language"
3. Change the data within the database using SQL commands.
4. Data manipulation and updating of all or specific set of records in tables, viewing the attributes of table's column.
5. Perform Join Operations
6. Extracting the data out of the database using group function, min, max, order by clause, where clause, having clause.
7. Create a Biological table by defining constraints, like Primary Key, Foreign Key, Null and Unique constraints.
8. Demonstrate programs for Procedure, function, Exceptional handling, trigger
   E-R Diagrams with reference to Biological Database.

**PRACTICAL PAPER-VI: Advanced Biophysical Techniques (45L-4 Credits)**

1. Determination of absorption spectra of DNA.
2. Estimation of DNA by DPA method.
3. Estimation and Purity check of DNA using UV spectroscopy.
4. Estimation of RNA by Orcinol method.
5. Determination of functional group in a given sample using FTIR.
6. Study of given specimen using Inverted Microscope.
7. Demonstration of X-ray Diffraction (XRD)
8. Demonstration of NMR spectroscopy.

. **PRACTICAL PAPER-VII: Computational Structure Biology and Drug designing**

**(45L-4 Credits)**

1. Accessing to Structural Databases and Data retrieval using RCSB PDB, CSA, PDBe, PDBeChem, PDBeFold, PDBeMotif, PdbSum.
2. Structural classification using CATH, SCOP resources.
3. Secondary structure prediction using SOPMA and GOR.
4. Homology modeling by SWISSMODEL, and Modeller 9V2 and Model Validation using RAMPAGE or PROCHECK,
5. Prediction of protein-protein, protein-DNA, protein-ligand interactions and
6. Drugbank and Chembank databases and Design of ligands using ACD lab and Chemsketch

7. Development of lead library and high throughput screening using *in silico* ADMET Properties.
8. Docking studies using AUTODOCK and HEX.

**OPEN ELECTIVE**

**PRACTICAL PAPER-VIII: (A) RESEARCH METHODOLOGY AND IPR**

**(45L-4 Credits)**

1. Access to various scientific Journals and data retrieval.
2. Preparation of manuscript for publication.
3. Presentation of a scientific Paper / Document using power point
4. Preparation and presentation of scientific poster for conference using power point.
5. Performing plagiarism check in the manuscript.
6. Access to patent web sites and preparation of report on IPR.
7. Chi-square tests
8. ANOVA

**OPEN ELECTIVE**

**PRACTICAL PAPER-VIII: (B) ADVANCE PHARMACEUTICALS (45L-4 Credits)**

1. Powder characterization: Microscopy – Particle size analysis, calculation of shape factors.
2. Powder Characterization: Compression and compaction – Huckel plot studies, tensile strength.
3. Solubilization:
    - Effect of dielectric constant on solubility
    - Complexation
    - Ternary phase diagram.
    - Solid dispersion
4. Stability of multiple emulsions
5. Polymer science: Rheological and thermal characterization of polymers and Stability study
6. Degradation kinetic study of a drug in a solution.
7. Accelerated stability studies of a formulation.
8. Dissolution studies of various dosage forms.

❖ **SEMINAR-III** **(25 Marks, Credit-1)**

**M. Sc. BIOINFORMATICS SYLLABUS**

**SEMESTER- IV**

**PAPER-XIII: BIOLOGICAL SIMULATION AND MODELING (45L- 4 CREDITS)**

**Unit-I: Basics of Simulations:** Introduction, general principles, models in simulations, quantum chemistry, Schrodinger equation, potential energy functions, energy minimization (global and local minima), molecular modeling methods. **(10)**

**Unit-II: Molecular Mechanics:** Definition, balls and springs, force fields; stretch, bend, torsion, etc, conformational search, full geometry optimization methods ZDO, MNDO, CNDO, NDDO, AMI, PM3, RMI, mechanics of biomacromolecules. **(10)**

**Unit-III: Molecular Dynamics:** Newton's equation for particles, Verlet and related algorithms, types of dynamics simulations; adiabatic, constant T, simulated annealing, molecular dynamics methodology, docking simulations, dynamics of biomacromolecules. **(10)**

**Unit-IV: Introduction to Python:** Introduction to python, working with data, program organization and functions, modules and libraries, classes and objects. **(8)**

**Unit-V: Programming with Python:** Python object system; inside the python object system, testing and debugging, iterators and generators, working with text, processors**.** **(7)**

**Reference Books:**

[1] Robert A. Muenchen and Joseph M. Hilbe. R for Stata Users. Statistics and Computing. Springer, 2010. ISBN: 978-1-4419-1317-3.

[2] Rob Kabacoff. R in Action. Manning, 2010. | http://www.manning.com/kabacoff ]

[3] Christian Robert and George Casella. Introducing Monte Carlo Methods with R. Use R. Springer, 2010. ISBN: 978-1-4419-1575-7.

**PAPER-XIV: CLINICAL BIOINFORMATICS (45L-4 Credit)**

**Unit-I: Next Generation Sequencing; Introduction**, Process, Application, NGS Platforms & Techniques, **NGS Tools:** Data & Data Formats, introduction to R scripting and QC tools PrinSek, BAMStats FASTX Toolkit FastQC, HTQC, Pyrocleaner and QPLOT, NGS Methods: Reference Based Genome Assembly, De Novo Genome Assembly, Transcriptomics, Epigenomics, Genome Mapping, Microarray Data Analysis, RNA Sequence Analysis and NGS Data Annotation. **(12)**

**Unit-II: Medical Bioinformatics:** Basic understanding, causes and available treatment strategies for bacterial and viral and parasitic diseases, Neurodegenerative disorders, Disease of circulatory system and respiratory system, Cancer, Genetic diseases. Introduction to pathology informatics, study of pathogen genomes (bacteria, fungi and viruses), databases, computational study of host–pathogen interactions (Animals and Plants). **(10)**

**Unit-III: Clinical Data Analysis:** Introduction to Medical coding, International Classification of Disease-10, Pharmacoviglance, Tools for Clinical trial data analysis and management. **(9)**

**Unit-IV: System and Functional Biology:** Pharmacogenomic: Introduction, History, Application and Challenges. System Biology, System structures, system dynamics Metabolomics: Introduction to Metabolome, Metabolites, Metabonomics, Analytical technologies, applications. **(9)**

**Unit-V: Genome sequencing projects and applications:** human Genome Project Introduction, Applications, Challenges of HGP, Introduction to various genome sequencing projects and their implications in human health and diseases, Comparative genome analysis Genome data visualization using Ensemble and Mapviewer. **(5)**

**References:**

1. Eija Korpelainen, Jarno Tuimala, Panu Somervuo, Mikael Huss, Garry Wong 2014: RNA-seq Data Analysis: A Practical Approach by Chapman & Hall/CRC Mathematical and Computational Biology

2. Robert Gentleman: 2008 R Programming for Bioinformatics by Chapman and Hall/CRC

3. Shui Qing Ye 2015: Big Data Analysis for Bioinformatics and Biomedical Discoveries by Chapman and Hall/CRC

4. Bentley DR, Balasubramanian S, Swerdlow HP, et al. Accurate whole human genome sequencing using reversible terminator chemistry. Nature. 2008; 456:53-59

**PAPER-XV: ADVANCED MOLECULAR BIOLOGY (45L-4 Credits)**

**Unit-I: PCR Techniques and Applications**: Introduction to PCR, types of PCR; Real time PCR, Reverse transcription PCR , Multiplex-PCR, Designing of GSP, RAPD and 16s rRNA primers. In vitro amplification of DNA, DNA sequencing, Site Directed Mutagenesis; Introduction to SDM, Methodology and applications. **(9)**

**Unit-II: rDNA Technology:** Genomic library; Shotgun method, construction and screening of gene fragments, cDNA Library. Blotting Techniques; Preparation o f DNA and RNA Probes, Southern, Northern, Western and Southwestern blotting techniques. Hybridization techniques: Colony Hybridization, Plaque Hybridization, *in situ* hybridization, Autoradiography. **(9)**

**Unit-III: Molecular Markers and Applications:** Restriction fragment length polymorphism (RFLP), Amplified fragment length polymorphism (AFLP), Random amplification of polymorphic DNA (RAPD), Simple sequence length polymorphism (SSLP), Variable number tandem repeat (VNTR), Microsatellite polymorphism or Simple sequence repeat (SSR), Single nucleotide polymorphism (SNP), Short tandem repeat (STR), DNA Finger printing and Microarray. **(9)**

**Unit-IV: Protein Purification Techniques:** Isolation, Production and Purification (Ultra filtration, Ammonium sulphate precipitation, Dialysis. Column chromatography; Gel filtration, Ion exchange, Affinity, HPLC and GLC. Electrophoresis; Basic principles of electrophoresis, SDS-PAGE, Native PAGE, IEF, 2D electrophoresis; Detecting proteins on gel, Electro blot, Image analysis, Digital imaging, Spot detection and quantification, Gel matching and Analysis. **(9)**

**Unit-V: Protein Sequencing and Amino Acid Analysis:** Different methods of protein sequencing, automated Protein sequencers and amino acid analyzers. Analysis of protein sequences using ExPasy Tools and peptide mass fingerprint analysis using MASCOT. **(9)**

**References:**

1. Surzycki, S. 2000 Basic Techniques in Molecular Biology. Spring Verlag.
2. Celis, J.E., Cell Biology: A Laboratory Handbook 2nd Edition
3. Ninfa, A.J. and Ballou, D.P. 1998 Fundamental Laboratory Approaches for Biochemistry and Biotechnology.
4. Ausubel et. al. 2002 Short Protocols in Molecular Biology. Wiley.
5. Sambrook et. al. 2001 Molecular Cloning. CSHL.
6. Bartlett 2003 PCR Protocols: Methods in Molecular Biology, Vol. 226 2nd Edition.
7. Simpson, R.J. 2004 A Laboratory Mannual Purifying Proteins for Proteomics. Cold Spring Harbor Laboratory Press, New York.

**OPEN ELECTIVE**
**PAPER-XVI: (A) EMERGING AREAS OF BIOINFORMATICS**

**(45L- 4 Credits)**

**Unit-I: Chemoinformatics:** Introduction to chemoinformatics, evolution and history of chemical information science, prospectus of chemoinformatics, chemical information source, chemical databases, chemical structure representation (1D, 2D and 3D structures), molecular file formats (SMILES, MOL, SDF, etc), molecular descriptors. **(13)**

**Unit-II: Immunoinformatics:** Bioinformatics strategies for better understanding of immune function, future of computational modeling and prediction systems in clinical immunology, immunoinformatics overview, immunoinformatics databases and tools (IMGT, IEDB, Epitome, etc), prediction of MHC class I and II, prediction of T and B cell epitopes, reverse vaccinology and *in silico* vaccine designing. **(12)**

**Unit-III: Personalized Medicine:** Introduction, Single nucleotide Polymorphism (SNP) and related disorders, SNP Databases, Tools for analysis of SNP and Applications **(5)**

**Unit-IV: Bio-Nanotechnology:** Introduction to nanoparticles, biological, chemical and mechanical synthesis of nanoparticles, analysis of nanoparticles using UV-Visible spectroscopy, FTIR and NMR. Applications of nanoparticles. **(8)**

**Unit-V: Introduction to Biodiversity Informatics:** Global patterns of distribution of biodiversity, basic principles of taxonomy and phylogeny, modern taxonomical methods**,** Molecular data types, generation and analysis, molecular databases, taxonomic database working group (TDWG), standards, compatibility and interoperability, botanical library and systematic databases, online biodiversity and ecosystem based database. **(7)**

**References:**

1. Gasteiger, 2003 Chemoinformatics A Text Book.
2. Bujnicki, J.M. 2004 Practical Bioinformatics (Series: Nucleic Acids & Molecular Biology Vol. 15). Springer.
3. Hassan, A.S. 2004 Bioinformatics: Principles and Basic Internet. Trafford Publishing.
4. Kohane, I.S., Kho, A. and Buthe, A.J. 2002 Microarrays for an Integrative Genomics. Barnes & Noble, MIT Press.
5. Lengauer, T. et. al. 2001 Bioinformatics: From Genomes to Drugs. Wiley-VCH.
6.Tudor, I.O., Mannhold, R. Kubinyi, H. and Folkers, G. Chemo Informatics in Drug Discovery (Methods and Principles in Medicinal Chemistry).7.Jensen, F. Introduction to Computational Chemistry. John Wiley & Sons

**OPEN ELECTIVE**
**PAPER XVI: B) MOLECULAR MEDICINE (45L-4 Credits)**

**Unit-I: Human Molecular Genetics:** Human genome project; Sequence Architecture of human genome; Blood and Blood group Antigens; MHC Antigen – HLA; Identification and isolation of disease genes – Positional cloning, Functional cloning, Microarray technology; Pre-natal diagnosis - Chorionic villus sampling, Amniocentesis; Forensic testing - DNA fingerprinting, DNA footprinting, Paternity testing. **(10)**

**Unit-II: Genetic Diseases in Human:** Cystic fibrosis, Duchenne muscular dystrophy, Haemoglobinopathies, Agammaglobulinemia, Marfan syndrome, Huntington's disease, Phenylketonuria, Down syndrome, Parkinson's Disease, Alzhesimer's Disease. **(8)**

**Unit-III: Stem Cell as Regenerative medicine:** Introduction; Stem cell sources; Unique properties of stem cells; Classification - Embryonic stem cells, Adult stem cells; Similarities and differences between adult and embryonic stem cells; Applications of Embryonic stem cells and ethical issues associated with it; Adult stem cell Differentiation, plasticity, types of adult stem cells; Stem cell specific transcription factors - Induced pluripotent stem cells (iPSC); Therapeutic applications as regenerative medicine. **(15)**

**Unit-IV: Gene Therapies:** Introduction; Types of Gene therapy: Somatic and Germ line gene therapy, *in-vivo* and *ex-vivo* gene therapy; Virus based vehicle for gene therapy, Non Viral Methods of Gene transfer. **(5)**

**Unit-V: Pharmacogenetics:** Steps involved in Drug Discovery/Design- *In silico* method, Structure based method, Nature and Sources of drugs; Route of drug administration; Absorption and Bioavailability of drugs in system; Excretion of drugs from system; Pharmacogenetics study of drug. **(7)**

**References:**


1. Peter Sudbery, Ian Sudbery, 2009, Human Molecular Genetics, 3rd edition, Pearson education limited.
2. Leaf Huang, Mien-Chie Hung, Ernst Wagner, 1999, Non viral vectors for gene therapy, Academic press.
3. Max Levitan, Ashley Montagu, 1977, text book of Human Genetics, 2nd Ed. Oxford University press, N.Y.
4. Tom Strachan & Andrew P. Read. 2004, Human Molecular Genetics, 2nd Ed. John Wiley & Sons. (Asia) PTE Ltd.
5. Ricki Lewis. Human Genetics- Concepts and Applications, 3rd Ed.WCB, McGraw-Hill.
6. Amita Sarkar.2001, Human Genetics, Dominant Publishers, VOL No-1 & 2 New Delhi.
7. Nagy A, Gertenstein M, Vintersten K, Behringer R (2003). Manipulating the Mouse Embryo ,New York:Cold Spring Harbor Press.
8. Gilbert SF.(2000) Developmental biology, 6th edition Sunderland,MA: Sinauer Associates, Inc.

**PRACTICAL PAPER-IX: BIOLOGICAL SIMULATION & MODELING, CLINICAL BIOINFORMATICS AND ADVANCED MOLECULAR BIOLOGY (45L, Credits-4)**

**Biological Simulation & Modeling**

1. Molecular dynamics and simulation using Gromacs and VMD tools
2. Model building, energy minimization of biomolecules using simulation tools.
3. Model building of oligopeptides / oligonucleotides using Pymol and DS tools.
4. Geometry optimization of biomolecules using simulation tools.
5. Practical's based on Python.

**Clinical Bioinformatics**

6. Practical's based on R language.
7. Study online Next Generation sequencing resources and databases.
8. Study of PrinSek, BAMStats FASTX Toolkit FastQC, HTQC, Pyrocleaner and QPLOT tools.
9. Study of Microarray Data Analysis tools and databases.
10. Introduction of International Classification of Disease-10 codes.
11. Study of Human genome project database and genome analysis tools

**Advanced Molecular Biology**

12. Isolation of Genomic DNA from different sources (blood, soil & hair).
13. Isolation of total cellular RNA.
14. Isolation and purification of proteins.
15. Zymogram analysis by Native PAGE and Determination of molecular weight of proteins by SDS-PAGE.
16. PCR Amplification of a given gene and Gel electrophoresis.

**OPEN ELECTIVE**

**PRACTICAL PAPER-X: (A) EMERGING AREAS OF BIOINFORMATICS (50 Marks, Credits-2)**

1. Study of Immuno-informatics resource – IMGT.
2. Genome data analysis using Ensembl and Mapviewer.
3. Study of SNP Databases and analysis tools.
4. Epitope prediction and vaccine designing.
5. Synthesis of nanoparticles by chemical and biological methods.
6. Chemical structures retrieval from PubChem, Chemspider, and ChEBI chemical databases.
7. Study of Chemical structure file formats- SMILES, MOL and SDF.
8. Study of Biodiversity databases.

**OPEN ELECTIVE**
**PRACTICAL PAPER-X: (B) MOLECULAR MEDICINE (50 Marks, Credits-2)**

1. Isolation of Genomic DNA from different sources (dried blood & hair).
2. Study of Sickled RBCs.
3. Demonstration of Study of Flow cytometer
4. Isolation and quantification of hemoglobin from blood
5. Separation of serum from plasma
6. Estimation of alkaline & acid phosphatase activity in blood plasmas
7. Study of Genetic Diseases.
8. Isolation and cultivation of lymphocytes

**PRACTICAL PAPER XI: PROJECT DISSERTATION AND VIVA VOCE: Students have to begin their projects in 3rd Semester and submit the report in 4th Semester. (50 Marks, Credits-2)**

**SEMINAR-IV (25 Marks, Credits-1)**