

**GANDHI INSTITUTE OF TECHNOLOGY AND
MANAGEMENT**

(GITAM)

(Deemed to be University U/S 3 of UGC Act, 1956)

VISAKHAPATNAM

Accredited by NAAC with 'A' Grade



REGULATIONS & SYLLABUS

Master of Science

in

Bioinformatics

Program Code : SPRBI 200704

(w.e.f admitted batch 2014 -15)

Website: www.gitam.edu

REGULATIONS

(w.e.f. admitted batch 2014-15)

1.0 ADMISSIONS

1.1 Admissions into M.Sc. (Bioinformatics) programme of GITAM University are governed by GITAM University admission regulations.

2.0 ELIGIBILITY CRITERIA

2.1 A pass in any B.Sc. degree are equivalent with any two of the following subjects: Agriculture, Aqua Culture, Biochemistry, Bioinformatics, Biotechnology, Botany, B.Pharm, BPT, Chemistry, Computer Sciences, Environmental Science, Food and Nutrition, Genetics, Home science, Mathematics, Medical Lab Technology, Microbiology, Physics, Veterinary Sciences, Zoology or B.Tech in CSE/IT/Biotechnology/Bio-medical.

2.2 Admissions into M.Sc. will be based on the following:

- (i) Score obtained in GAT (PG), if conducted.
- (ii) Performance in Qualifying Examination / Interview.

The actual weightage to be given to the above items will be decided by the authorities before the commencement of the academic year.

3.0 STRUCTURE OF THE M.Sc. PROGRAMME

3.1 The Programme of instruction consists of:

- (i) A core programme imparting to the student specialization of the stream concerned.
- (ii) Carry out a project approved by the Department and submit a report.

Each academic year consists of two semesters. M Sc programme has a curriculum and Name of the Course content (syllabi) for the Name of the Courses recommended by the Board of Studies concerned and approved by Academic Council.

3.3 Project Dissertation has to be submitted by each student individually.

4.0 CREDIT BASED SYSTEM

4.1 Each Name of the Course is assigned certain number of credits which will depend upon the number of contact hours (lectures and tutorials) per week.

4.2 In general, credits are assigned to the Name of the Courses based on the following contact hours per week per semester.

One credit for each Lecture / Tutorial hour.

One credit for two hours of Practicals.

Two credits for three (or more) hours of Practicals.

4.3 The curriculum of M.Sc. programme is designed to have a total of 80 credits for the award of M Sc degree. A student is deemed to have successfully completed a particular semester's programme of study when he / she earns all the credits of that semester i.e., he / she has no 'F' grade in any Name of the Course of that semester.

5.0 MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

6.0 REGISTRATION

Every student has to register himself/herself for each semester individually at the time specified by the Institute / University.

7.0 CONTINUOUS ASSESSMENT AND EXAMINATIONS

7.1 The assessment of the student's performance in each Name of the Course will be based on continuous internal evaluation and semester-end examination. The marks for each of the component of assessment are fixed as shown in the Table 1.

Table 1: Assessment Procedure

S.No.	Component of assessment	Marks allotted	Type of Assessment	Scheme of Examination
1	Theory	30	Continuous evaluation	(i) Two mid semester examinations are to be conducted for 10 marks each. (ii) 5 marks are allocated for quiz. (iii) 5 marks are allocated for assignments.
		70	Semester-end examination	The semester-end examination question paper in theory Name of the Courses will be for a maximum of 70 marks.
	Total	100		
2	Practicals	100	Continuous evaluation	(i) One examination for a maximum of 20 marks will be conducted by the teacher handling the lab Name of the Course during mid of the semester (ii) One examination for a maximum of 70 marks will be scheduled at the end of the semester by the Head of the Department concerned. HoD will appoint one examiner from the department not connected with the conduct of regular lab, in addition to the teacher who handled the lab Name of the Course in the semester. (iii) 10 marks are allocated regular performance in the lab.
3	Project work (IV semester)	200	Project evaluation	(i) 150 marks are allocated for evaluation of the project work dissertation submitted by the candidate at the end of the semester. (ii) 50 marks are allocated for the presentation of the project work and viva-voce at the end of the semester.
4	Viva -Voce	50	Viva-voce	50 marks are allocated for comprehensive viva to be conducted at the end of the each semester. HoD of the department concerned shall appoint two examiners.

8.0 REAPPEARANCE

8.1 A Student who has secured 'F' Grade in any theory Name of the Course / Practicals of any semester shall have to reappear for the semester end

examination of that Name of the Course / Practicals along with his / her juniors.

- 8.2 A student who has secured 'F' Grade in Project work shall have to improve his report and reappear for viva – voce Examination of project work at the time of special examination to be conducted in the summer vacation after the last academic year.

9.0 SPECIAL EXAMINATION

- 9.1 A student who has completed the stipulated period of study for the degree programme concerned and still having failure grade ('F') in not more than 5 Name of the Courses (Theory / Practicals), may be permitted to appear for the special examination, which shall be conducted in the summer vacation at the end of the last academic year.
- 9.2 A student having 'F' Grade in more than 5 Name of the Courses (Theory/practicals) shall not be permitted to appear for the special examination.

10.0 ATTENDANCE REQUIREMENTS

- 10.1 A student whose attendance is less than 75% in all the Name of the Courses put together in any semester will not be permitted to attend the end - semester examination and he/she will not be allowed to register for subsequent semester of study. He /She has to repeat the semester along with his / her juniors.

- 10.2** However, the Vice Chancellor on the recommendation of the Principal / Director of the University college / Institute may condone the shortage of attendance to the students whose attendance is between 66% and 74% on genuine medical grounds and on payment of prescribed fee.

11.0 GRADING SYSTEM

- 11.1 Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each Name of the Course. The letter grades and the corresponding grade points are as given in Table 2.

Table 2: Grades and Grade Points

Grade	Grade points	Absolute Marks
O	10	90 and above
A+	9	80 – 89
A	8	70 – 79
B+	7	60 – 69
B	6	50 – 59
C	5	40 – 49
F	Failed, 0	Less than 40

11.2 A student who earns a minimum of 5 grade points (C grade) in a Name of the Course is declared to have successfully completed the Name of the Course, and is deemed to have earned the credits assigned to that Name of the Course. However, a minimum of 28 marks is to be secured at the semester end examination of theory Name of the Courses in order to pass in the theory Name of the Course.

12.0 GRADE POINT AVERAGE

12.1 A Grade Point Average (GPA) for the semester will be calculated according to the formula:

$$\text{GPA} = \frac{\sum [C \times G]}{\sum C}$$

Where

C = number of credits for the Name of the Course,

G = grade points obtained by the student in the Name of the Course.

12.2 Semester Grade Point Average (SGPA) is awarded to those candidates who pass in all the Name of the Courses of the semester.

12.3 To arrive at Cumulative Grade Point Average (CGPA), a similar formula is used considering the student's performance in all the Name of the Courses taken in all the semesters completed up to the particular point of time.

12.4 The requirement of CGPA for a student to be declared to have passed on successful completion of the M Sc programme and for the declaration of the class is as shown in Table 3.

Table 3: CGPA required for award of Degree

Distinction	$\geq 8.0^*$
First Class	≥ 7.0
Second Class	≥ 6.0
Pass	≥ 5.0

* In addition to the required CGPA of 8.0, the student must have necessarily passed all the Name of the Courses of every semester in **first attempt**.

13.0 ELIGIBILITY FOR AWARD OF THE M.Sc. DEGREE

13.1 Duration of the programme:

A student is ordinarily expected to complete the M.Sc. programme in four semesters of two years. However a student may complete the programme in not more than four years including study period.

13.2 However the above regulation may be relaxed by the Vice Chancellor in individual cases for cogent and sufficient reasons.

13.3 A student shall be eligible for award of the M.Sc. degree if he / she fulfils all the following conditions.

- a) Registered and successfully completed all the Name of the Courses and projects.
- b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time.
- c) Has no dues to the Institute, hostels, Libraries, NCC / NSS etc, and
- d) No disciplinary action is pending against him / her.

13.4 The degree shall be awarded after approval by the Academic Council.

RULES

1. With regard to the conduct of the end-semester examination in any of the practical Name of the Courses of the programme, the Head of the Department concerned shall

appoint one examiner from the department not connected with the conduct of regular laboratory work, in addition to the teacher who handled the laboratory work during the semester.

2. In respect of all theory examinations, the paper setting shall be done by an external paper setter having a minimum of three years of teaching experience. The panel of paper setters for each Name of the Course is to be prepared by the Board of Studies of the department concerned and approved by the Academic Council. The paper setters are to be appointed by the Vice Chancellor on the basis of recommendation of Director of Evaluation / Controller of Examinations.
3. The theory papers of end-semester examination will be evaluated by two examiners. The examiners may be internal or external. The average of the two evaluations shall be considered for the award of grade in that Name of the Course.
4. If the difference of marks awarded by the two examiners of theory Name of the Course exceeds 14 marks, the paper will have to be referred to third examiner for evaluation. The average of the two nearest evaluations of the three shall be considered for the award of the grade in that Name of the Course.
5. Panel of examiners of evaluation for each Name of the Course is to be prepared by the Board of Studies of the department concerned and approved by the Academic Council.
6. The examiner for evaluation should possess post graduate qualification and a minimum of three years teaching experience.
7. The appointment of examiners for evaluation of theory papers will be done by the Vice Chancellor on the basis of recommendation of Director of Evaluation / Controller of Examinations from a panel of examiners approved by the Academic Council
8. Project work shall be evaluated by two examiners at the semester end examination. One examiner shall be internal and the other examiner will be external. The Vice Chancellor can permit appointment of second examiner to be internal when an external examiner is not available.

M.Sc. Bioinformatics - Scheme of Instruction

I SEMESTER

Sl. No.	Course Code	Name of the Course	Credits	Scheme of Instruction			Scheme of Examination	
				Hours per week			Sem. End Exam.	Con. Eval.
				L/T	---	D/P		
1	SPRBI 101	Cell Biology and Cell Signalling	4	4			70	30
2	SPRBI 102	Essentials of Biochemistry	4	4	--	3	70	30
3	SPRBI 103	Basics of Mathematics and Biostatistics	4	4	--	3	70	30
4	SPRBI 104	Computers Basics and Programming in Bio C	4	4	--	3	70	30
PRACTICAL								
	SPRBI 111	Cell Biology and Biochemistry Lab	2	---	12	6	---	100
	SPRBI 112	Biostatistics and C Programming Lab	2	---	12	6	---	100
	SPRBI 113	Viva – voce	1	---	---	---	---	50
		Total	21					650

M.Sc. Bioinformatics - II SEMESTER

Sl. No.	Course Code	Name of the Course	Credits	Scheme of Instruction			Scheme of Examination	
				Hours per week			Sem. End Exam.	Con. Eval.
				L/T	---	D/P		
1	SPRBI 201	Molecular Biology and Genetic Engineering	4	4	---	3	70	30
2	SPRBI 202	Microbiology and Immunology	4	4	---	3	70	30
3	SPRBI 203	DBMS and Biological Databases	4	4	---	3	70	30
4	SPRBI 204	Biological Sequence Analysis	4	4	---	3	70	30
PRACTICALS								
	SPRBI 211	Microbiology, Molecular Biology and Immunology Lab	2	---	12	6	---	100
	SPRBI 212	Biological Databases and Sequence Analysis Lab	2	---	12	6	---	100
	SPRBI 213	Viva – voce	1	---	---	---	---	50
		Total	21					650

M.Sc. Bioinformatics - III SEMESTER

Sl. No.	Course Code	Name of the Course	Credits	Scheme of Instruction			Scheme of Examination	
				Hours per week			Sem. End Exam.	Con. Eval.
				L/T	---	D/P		
1	SPRBI 301	Molecular Modelling	4	4	---	3	70	30
2	SPRBI 302	Biocomputing	4	4	---	3	70	30
3	SPRBI 303	Genomics	4	4	---	3	70	30
4	SPRBI 304	Proteomics	4	4	---	3	70	30
PRACTICALS								
	SPRBI 311	Molecular Modelling and Biocomputing Lab	2	---	12	6	---	100
	SPRBI 312	Genomics and Proteomics Lab	2	---	12	6	---	100
	SPRBI 313	Viva – voce	1	---	---	--	50	
		Total	21				650	

M.Sc. Bioinformatics - IVSEMESTER

Sl. No.	Course Code	Name of the Course	Credits	Scheme of Instruction			Scheme of Examination	
				Hours per week			Sem. End Exam.	Con. Eval.
				L/T	---	D/P		
1	SPRBI 401	Drug Designing and Bioethics	4	4	---	3	70	30
2	SPRBI 421 SPRBI 422 SPRBI 423	Systems Biology/ Machine Learning and Implementation of Algorithms/ Advanced Bioinformatics	4	4	---	3	70	30
PRACTICALS								
	SPRBI 411	Drug Designing Lab	2	---	12	3	70	30
	SPRBI 412	Viva – voce	1	---	---	--	---	50
	SPRBI 413	Project Work and Seminar	6	---	---	---	200	---
		Total	17				550	

M.Sc. Bioinformatics (I Semester)

SPRBI 101: Cell Biology and Cell Signalling

UNIT-I

Cell Structure and Organelles: Structural organization of prokaryotic and eukaryotic cells, Ultra structure of cellular components and their functions – Chloroplasts, Mitochondria, Endoplasmic reticulum, Golgi complex, Lysosomes and Peroxisomes, Ribosomes and Nucleus.

UNIT-II

Cellular Membranes and Cytoskeleton: Cellular Membranes – Structure and Function, Various types of transport, Channels and Carriers. Membrane potential, Extracellular matrix, Cell motility. Cytoskeletal elements and their regulation – Actin, Myosin, Microfilaments, Tubulin, Molecular motor proteins – Actin and Microtubule.

UNIT-III

Overview of Cell Cycle: Cell cycle and its regulation – Phases of cell cycle, Cyclins, CDKs, CKIs, Cell cycle checkpoints, Biochemical switches, Control of cell growth, Tumor suppressor genes and oncogenes, Programmed cell death.

UNIT-IV

Cell Signaling Pathways: Types of signaling molecules and their receptors, Signal transduction, Signaling networks via GPCR, PKA, PKC, CaM kinase, Signaling through enzyme coupled cell surface receptors- RTKs, MAPK, JAK-STAT.

UNIT-V

Cell Signaling Pathways: Signaling pathways dependent on regulated proteolysis-WnT signaling, Hedgehog protein signaling, NF- κ B dependent signaling, Lipid based signaling.

Text Books:

1. Molecular Biology of the cell – Bruce Alberts, 5th Ed.
2. The Cell: A molecular approach – CM. Cooper, 5th Ed.
3. Cell Biology – Gerald Karp, 6th Ed.
4. Lewin's Genes XI – Kilpatrick, Student Ed.
5. Molecular Cell Biology – Lodish, 6th Ed.

M.Sc. Bioinformatics (I Semester)

SPRBI 102: Essentials of Biochemistry

UNIT-I

Principles of Biophysical Chemistry: Structure of atoms, molecules and chemical bonds, Ionization of water, Acids and bases, Buffers and its action – Henderson Hassel Bach equation, Stabilizing interactions – Vander Waals, Electrostatic, H-bond and Hydrophobic interactions.

UNIT-II

Bioenergetics: Laws of thermodynamics, Thermodynamic quantities – Free energy, Enthalpy, Entropy, Chemical logic and common biochemical reactions – free radical reactions, Group transfer reactions, oxidation-reduction reactions, Energy interconversions in living organisms, High-energy compounds, Electron Transport Chain and its inhibitors.

UNIT-III

Carbohydrates and Lipids: Classification, Chemical properties, Structural and functional roles of Carbohydrates, Glycolysis, TCA Cycle and their regulation, HMP Shunt pathway, Gluconeogenesis. Classification, Chemistry and function of Lipids, Outlines of β -oxidation and its significance, Synthesis of fatty acids.

UNIT-IV

Proteins and Nucleic acids: Amino acids – Classification based on R-group, Structure and Physico-chemical properties, Sequencing and Synthesis of Peptides, Proteins – Classification, Structural organization, Conformational properties, Ramachandran plot. Nucleic acids – Bases, Nucleotides, RNA and DNA, Different structural forms of DNA, Types of RNA, Sequencing and Synthesis of Oligonucleotides.

UNIT-V

Enzymology: Nomenclature and Classification, Remarkable properties of enzymes – Enzyme activation and specificity, General mechanism of action of enzymes, Mapping of active site, Factors affecting enzyme activity, Types of enzyme catalysis, Single-substrate enzyme kinetics, Enzyme inhibition and regulation.

Text Books:

1. Textbook of Biochemistry – Lehninger and Nelson and Cox, 5th Ed.
2. Textbook of Biochemistry – West and Todd.
3. Lehninger's Principles of Biochemistry – Nelson and Cox, 5th Ed.
4. Biochemistry – Stryer, 6th Ed.
5. Biochemistry – Voet and Voet, 4th Ed.

M.Sc. Bioinformatics (I Semester)

SPRBI 103: Basics of Mathematics and Biostatistics

UNIT-I

Basics of Mathematics: Linear algebra – Groups, Linear maps and Matrices, Solution of simultaneous and quadratic equations, Cubic equations – Solving system of equations by crammer's rule. 2D coordinate geometry – Straight line, slope, intersection, equation of a line, Point of intersection of a line, Parallel and perpendicular lines, Angle between lines.

UNIT-II

Limits: Differentiation of elementary functions, sum and product of functions. Integration of simple functions, definite integrals.

UNIT-III

Basics of Statistics: Biostatistics – Introduction and applications, Measures of central tendency – Mean, Median and Mode, Measures of dispersion – Range, Standard deviation, Standard error and Variance.

UNIT-IV

Probability and Sampling: Probability – Definition, Addition and Multiplication theorems, Conditional probability, Bayes' theorem, Random variables, Discrete and Continuous probability distribution. Probability distribution – Binomial, Poisson and normal distributions and their properties. Level of significance, Type I and Type II errors.

UNIT-V

Testing of Hypothesis: Students't' test, Chi-square test, Correlation co-efficient, Regression analysis, ANOVA.

Text Books:

1. Introduction to Mathematical methods in Bioinformatics. A. Isaev.
2. Discrete Mathematics, Malik.
3. Mathematics for Biological Sciences, Aitken
4. A text book of remedial Mathematics, G.K.Ranganath, Himalaya Publishing House.
5. Trigonometry, Algebra and Calculus, Veerarajan, T., Third Edition, Tata McGraw Hill Publishing Co. Ltd.
6. Biostatistics, Arora, P.N. and Malhan, P.K., First Edition, Himalaya Publishing House.

M.Sc. Bioinformatics (I Semester)

SPRBI 104: Computers Basics and Programming in Bio C

UNIT-I

Overview of Computers: Computers – History, Components and Types, Operating systems – Functions, Types – Windows, UNIX, Linux and Macintosh. Networking concepts – Properties, Topologies, Communication protocols, Types of Networks – LAN, WAN, MAN and Applications of Internet. High performance computing.

UNIT-II

Basics of C: Introduction to C, Features of C, Character Set, Constants, Variables, Data types, Key words, Operators, Typecasting, Basic I/O functions.

UNIT-III

Control Structures and Functions: Control structures – If statement, if-else statement, nested if-else, Switch Statement, Break statement, Continue statement, go to statement. Loops – For loop, while loop, do-while loop. Functions – Need of functions, function parameters, Passing values between functions, Calling Convention, function declaration and prototypes, Recursion.

UNIT-IV

Arrays and Strings: Arrays – Introduction, Initialization, Passing array elements to a function, Pointers and arrays, two-dimensional array. Strings –String declaration, Array of string and standard library string functions.

UNIT-V

Structure, Unions and File handling: Structure, Declaration of structure members and structure variables, Storage of elements, Initialization of structure, Nested structure, Array of structures. Unions – Declaration and initialization, Difference between Union and Structure. File handling

Text Books:

1. Let us C – Yashwant K., 4th Ed.
2. The C programming language – Ritchie, D.M., 2nd Ed.
3. Computer Fundamentals and Applications –Balaguruswamy E., 2nd Ed.
4. Fundamentals of Information technology – Alexis Leon and Mathews Leon, 1st Ed.
5. Programming with C – Venugopal, K.R., Sudeep R.P., 2nd Ed.
6. Introduction to Computers – Norton, P., 6th Ed.

M.Sc. Bioinformatics (I Semester)

SPRBI 111: Cell Biology and Biochemistry Lab

1. Preparation of specimens and Handling of microscope.
2. Identification of various stages in Mitosis using onion root tips.
3. Identification of various stages in Meiosis using onion florescence.
4. Isolation and Identification of Mitochondrial fraction from plant tissue.
5. Estimation of total sugar content in given plant tissue sample by anthrone method.
6. Estimation of fat content in given sample by chloroform-methanol method.
7. Determination of Protein content by Lowry's and Spectrophotometric method.
8. Separation of amino acids using paper chromatography.
9. Titration curve of glycine, histidine and glutamic acid.
10. Assay of salivary amylase/phosphatase/trypsin/papain activity.
11. Effect of substrate concentration on enzyme kinetics.
12. Effect of pH on enzyme kinetics.
13. Effect of temperature on enzyme kinetics.
14. Estimation of DNA by diphenylamine method.
15. Estimation of RNA by orcinol method.

M.Sc. Bioinformatics (I Semester)

SPRBI 112: Biostatistics and C Programming Lab

1. Calculation of Mean, Median and Mode of a given data.
2. Calculation of SD and Variance for a given data.
3. Estimation of Correlation co-efficient for the given data by Pearson's and Spearman's methods.
4. Regression analysis.
5. Calculation of goodness of fit by χ^2 test.
6. Testing of Hypothesis by Student 't' test.
7. ANOVA for the given data.
8. Program for Transcription and Translation using C
9. Program for Concatenation of 2 strings using C.
10. Program for Base Count of DNA.
11. Program for Calculating GC% using C.
12. Program for Calculating Melting Point of DNA.
13. Program for Reverse Complement.
14. Program for Amino acid Sequence Count.
15. Sequence Alignment and Motif search.

M.Sc. Bioinformatics (II Semester)

SPRBI 201: Molecular Biology and Genetic Engineering

UNIT-I

Genes and Genomes: Outline of Gene structure, Structural organization of genome, Chromatin remodelling, Prokaryotic genome, Inventory of Eukaryotic genome – Genes, Pseudogenes, Dispersed gene families, Tandem gene families, SINE'S, LINE's, Minisatellites, Microsatellites, Telomeres, Transposons, CpG Islands and DNA methylation, Epigenetic Regulation.

UNIT-II

Flow of Genetic Information: Models and Mechanism of DNA replication, DNA damage – Replication-mediated, Physical and Chemical agents, DNA repair mechanisms, DNA Recombination, Mutations – Point mutations, Inversions, Deletions and Duplications.

UNIT-III

Flow of Genetic Information: Prokaryotic and Eukaryotic Transcription – Mechanism and Regulation, Post-transcriptional processing. Protein synthesis in Prokaryotes and Eukaryotes, Protein – Processing, Folding, Sorting and Degradation.

UNIT-IV

Gene Manipulation Techniques: Restriction-Modification System, Ligation of DNA, Vectors – Cloning, Expression and Shuttle. Basic Techniques – Transformation, PCR, Gel Electrophoresis, Blotting, Fingerprinting - RFLP, RAPD, AFLP and STRs.

UNIT-V

Gene Manipulation Methods: Cloning – Functional, Positional and Subtractive, Synthesis and Construction of cDNA Library, Expression Libraries. Gene transfer methods in plants and animals, Gene Knock-out Strategies, Site-directed mutagenesis, Protein Engineering.

Text Books:

1. Lehninger's Principles of Biochemistry – Nelson and Cox, 6th Ed.
2. Molecular Biology of the Gene – James D. Watson, 4th Ed.
3. Lewin's Genes XI – Krebs, Goldstein and Kilpatrick.
4. Principles of Gene Manipulation and Genomics – Primrose and Twyman, 7th Ed.
5. Molecular Biology – Robert F. Weaver, 4th Ed.

M.Sc. Bioinformatics (II Semester)

SPRBI 202: Microbiology and Immunology

UNIT-I

Microbial World: Types and Classification of Microorganisms, Cellular components of Bacteria, Viruses and Fungi, Staining techniques, Microbial culture – Continuous and Synchronous, Effect of Biotic and Abiotic factors on microbial growth, Sterilization techniques. Microscopy – Simple, Compound, Phase contrast, Fluorescence, and Electron microscope.

UNIT-II

Principles of Disease and Epidemiology: Pathology – Infection and Disease, Normal micro biota, Relationship between Normal micro biota and Host, Opportunistic microorganisms, Co-operation among microorganisms. Classification of Infectious Diseases, Spread of Infections – Vectors and Reservoirs, Nosocomial Infections, Epidemiology of infectious diseases.

UNIT-III

Microbial Mechanisms of Pathogenicity: Adherence - Pathogen Associated Molecular Patterns (PAMPs), MAMPs, PRRs, Microorganisms entry into the host, Portals of entry and preferred portal of entry, Pathogens penetrating host defenses, Damaging host cells, Viral, Fungal, Protozoan pathogenicity, Drug resistance and Horizontal Gene Transfer (HGT).

UNIT-IV

Basics Concepts in Immunology: Immune systems – Innate and Adaptive, Sub-types of immunity- Humoral and Cell-mediated, Antigen processing and presentation, Membrane receptors for antigen-BCR, TCR and MHC, MHC polymorphism, Epitopes affinity and maturation, Immunoglobulin classes, Ag-Ab interactions, Hypersensitivity.

UNIT-V

Immunoinformatics: Principles and its uses, Tools and Web-resources, Epitope mapping and prediction of B-Cell and T-Cell, Computational vaccine design – Concept, Application and Workflow, Reverse vaccinology.

Text Books:

1. Microbiology: An introduction – Tortora, Funke and Case, 9th Ed.
2. Alcamo's Fundamentals of Microbiology – JC Pommerville, 9th Ed.
3. Immunology – J. Kuby, 6th Ed.
4. Immunology – S. Pathak, 3rd Ed.
5. Immunoinformatics: Bioinformatics strategies for better understanding of immune function – D. Flower, Novartis foundation.
6. Immunoinformatics: Predicting immunogenicity *Insilco* – DR. Flower.

M.Sc. Bioinformatics (II Semester)

SPRBI 203: DBMS and Biological Databases

UNIT-I

Introduction to DBMS: Database systems- Organization, Functions and Components of DBMS, Data abstraction, Database languages, Data Models – ER, Hierarchical, Network, Object-oriented and Relational, Distributed databases – Types, Functions, Pros and Cons. Parallel Databases, Multimedia databases, Basics of Data mining and OLAP.

UNIT-II

RDBMS and SQL: Codd's Rules, Keys, Data Normalization – Pitfalls in Relational database design, Decomposition, Functional dependencies, Different forms of Normalization, Indexing and Hashing. SQL-Introduction, Characteristics and Advantages, Basic structure of SQL queries, Set operations, Null values, Aggregate functions, Integrity constraints, SQL operators.

UNIT-III

Biological Databases: Nature and Types of Biological Data, Explosion of biological data, Database construction and analysis, Different Omics Studies, Major Bioinformatics resources- NCBI, EBI and Expasy. Nucleic acid sequence databases, Repositories for High-Throughput genomic sequences (EST, STS, GSS), Gene expression databases.

UNIT-IV

Protein databases: Sequence databases, 3D Structural databases, Structure classification databases, Domain and Motif databases, Protein-protein interaction databases.

UNIT-V

Metabolic pathway databases, Signaling pathway databases, Immunological databases, Human genetics databases, Enzymes and reactions databases.

Text Books:

1. Essentials of Database Management Systems – Alexis and Mathews.
2. Database System Concepts – Abraham, Korth and Sudarshan, 6th Ed.
3. The Complete Reference SQL – James and Paul, 2nd Ed.
4. Introduction to Bioinformatics – Arthur M. Lesk, 3rd Ed.
5. Bioinformatics and Functional Genomics – Jonathan Pevsner, 2nd Ed.
6. Essential Bioinformatics – Jin Xiong.

M.Sc. Bioinformatics (II Semester)

SPRBI 204: Biological Sequence Analysis

UNIT-I

Concepts in sequence analysis, File formats- GenBank, FASTA, GCG and MSF, Concepts of Sequence similarity, identity, homology and distances. Homologues, orthologues and paralogues, scoring matrices- concept, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, principles and derivation of PAM and BLOSUM matrices. Keyword-based searches using ENTREZ and SRS.

UNIT-II

Pairwise sequence alignments: Types of sequences, concepts of sequence alignment- Dot plot matrix for repeat matches and palindromic sequences, Dynamic programming in local and global alignments, Linear space algorithm, gap penalties function. Analysis of pair wise sequence alignment of nucleic acid and protein sequences, Needleman and Wunsch, Smith and Waterman algorithms and implementation, Sequence-based searches: BLAST and FASTA.

Analysis of regulatory RNA's, Databases and tools for prediction of RNA, secondary structure prediction by Nussinov folding algorithm, energy minimization, covariance models.

UNIT-III

Multiple sequence alignment (MSA): Concept of MSA, Scoring systems of MSA- sum-of-pairs scoring scheme and entropy based scoring schemes, approaches for MSA- multidimensional dynamic programming, progressive, hierarchical, iterative and profile alignment, MSA Algorithm of CLUSTALW and Pile Up and their application, dendrogram and its interpretation, Hidden Markov Models for pairwise and multiple sequence alignment, HMM-based Algorithm for MSA.

UNIT-IV

Sequence patterns and profiles: Basic concept of sequence patterns, motifs, profiles, tandem and interspersed repeats, Repeat finding, Types of pattern representations - consensus, regular expression, position weight matrices and sequence profiles. Algorithms for derivation and searching sequence patterns - MEME, PHI-BLAST, SCanProsite and PRATT, Algorithms for generation of sequence profiles- Profile Analysis method of Gribskov, profile HMM training HMMer, PSIBLAST, profile-based database searches using PSI-BLAST.

UNIT-V

Molecular phylogenetics: Concepts and applications of phylogeny, Taxonomy and phylogeny - Systematics, molecular evolution, nature of data used, description and types of phylogenetic trees, sequence graphs. Tree construction methods: Distance based methods – UPGMA, Neighbor Joining, FM, Minimum Evolution, Character based methods - Parsimony (Exhaustive, Branch and Bound, and heuristic) and Maximum Likelihood. Tree evaluation methods – Bootstrap, Probabilistic models of evolution – Jukes cantor model and Kimura model, Using the likelihood for inference. Combined multiple sequence alignment and phylogeny – Sankoff and Cedergren method, Use of tools such as Phylip, MEGA, PAUP.

Text Books:

1. Biological sequence analysis, Durbin, Eddy, Krogh and Mitchison, Eighth Edition, Cambridge University Press.
2. Essential Bioinformatics, Jin xiong, Cambridge University Press.
3. Bioinformatics: Sequence and Genome Analysis, Mount, D., First Edition, Cold Spring Harbor Laboratory Press.
4. Introduction to Bioinformatics, Lesk, A.M., First Edition, Oxford University Press.

M.Sc. Bioinformatics (II Semester)

SPRBI 211: Microbiology, Molecular Biology and Immunology Lab

1. Isolation of pure culture of microorganisms by streak plate, pour plate, spread plate and serial dilution
2. Determination of bacterial growth curve and generation time.
3. Staining of microorganisms by simple and Gram staining.
4. Isolation of genomic DNA from plant/animal/microbial sources.
5. Isolation of plasmid DNA from bacteria.
6. Restriction digestion and ligation of plasmid DNA.
7. Transformation of plasmid DNA into competent cells using calcium chloride method.
8. Isolation of RNA from yeast cells.
9. Gene Amplification by PCR.
10. Demonstration of Polymorphism in various DNA samples by RFLP technique.
11. Demonstration of Southern Blotting technique.
12. Demonstration of Ag-Ab interaction by Ouchterlony double immunodiffusion method.
13. Determination of Ag by radial immunodiffusion method.
14. Determination of Ag/Ab by ELISA.
15. Quantification of Ag by rocket immunoelectrophoresis.

M.Sc. Bioinformatics (II Semester)

SPRBI 212: Biological Databases and Sequence Analysis Lab

1. Major Bioinformatics Resources: NCBI, EBI, DDBJ.
2. Biological Literature Databases.
3. Nucleic Acid and Protein Sequence Databases.
4. Gene Expression Databases.
5. Protein 3D Structural Databases and Classification Databases.
6. Protein Domain and Motif Databases.
7. Metabolic and Signaling Pathway Databases.
8. Immunoinformatics Databases.
9. Searching Homologs using various BLAST Variants.
10. Sequence alignment using Needleman-Wunsch method.
11. Effect of scoring matrices and gap penalties on sequence alignment.
12. Multiple sequence alignment.
13. Use of HMM profiles.
14. Phylogenetic tree construction using UPGMA, NJ and Parsimony for protein and nucleic acid sequences.
15. RNA secondary structure prediction.

M.Sc. Bioinformatics (III Semester)

SPRBI 301: Molecular Modelling

UNIT-I

Introduction to Molecular Modelling: Representation of chemical compounds - Nomenclature, Line notations, Standard structure exchange formats, Representation of 3D structures and codes, Molecular surfaces, Molecular graphics.

Molecular Modelling Methods - Outline, Advantages and Disadvantages of Molecular Mechanics, Semi-Empirical, Ab-Initio and Density Functional Theory.

UNIT-II

Molecular Mechanics: Force Fields – Definition and Features, Functional Forms – Bond stretching, Angle bending, Torsional terms, Out-of-plane bending, Cross-terms, Electrostatic, Vander Waals and Hydrogen Bonding interactions. Force fields for small molecules and biomolecules.

UNIT-III

Quantum Mechanics based Chemical Models: Semi empirical based Models, Schrodinger equation, Born-Oppenheimer approximation, Hartree-Fock approximation, LCAO approximation, Roothaan-Hall equations, Configuration Interaction models, Moller-Plesse models, RHF model, Gaussian Basis Sets.

UNIT-IV

Energy Minimization and Simulations: Energy Minimization – Statement of Problem, Derivative and Non-Derivative Methods, Simulation Methods - Time Averages, Ensemble averages, Molecular Dynamics Methods, Monte Carlo Methods, Differences between MD and MC, Conformational Analysis.

UNIT-V

Structural Bioinformatics: Protein Structure Comparison and Alignment, Structural Alignment Methods - CE, VAST, DALI, SSAP, TM-align, Structural Quality Assurance - Structure as Models, Error Estimation and Precision, Stereo Chemical Parameters. Anfinsen Thermodynamic Hypothesis.

Text books:

1. Molecular Modelling: Principles and Applications – A.R. Leach 2nd Ed
2. Chemoinformatics – Johann Gasteiger, Thomas Engel, Wiley.
3. Computational Biochemistry and Biophysics –O M. Becker.
4. Structural Bioinformatics – Jenny and Philip, 2nd Ed.

M.Sc. Bioinformatics III Semester

SPRBI 302: Biocomputing

UNIT -I

Operating Systems: Unix/Linux- Basics, File systems, Essential Commands and Text Editors.

UNIT-II

PERL: Introduction, Data Types – Lists, Arrays and Hash, Scalar functions, Quoting basics, Functions and Subroutines, Operators and Control Structures, Pattern Matching and Regular Expressions, File Handling and Manipulation, Error handling, Special variables.

UNIT-III

BioPERL: BioPerl Modules - Sequences and Strings, Motifs and Loops, Debugging, Comprehensive PERL archive network, Data Structures and Algorithms for biology, Restriction maps and Restriction enzyme data, Working and analyzing with GenBank and BLAST data, Text and String Processing.

UNIT-IV

JAVA: Introduction and Applications, Variables and Operators, Control Structures, OOPs concept, Arrays, Applet class. HTML - Basics, Applet HTML tag. Database connectivity - TCP/IP, UDP, servers, clients.

UNIT-V

BIOJAVA: Setup, Alphabets and Symbols, Basic Sequence Manipulation, Translation, Proteomics, Sequence I/O, Annotations, Locations and Features, BLAST and FASTA, User Interfaces, Genetic Algorithms.

Text Books:

1. Beginning Perl for Bioinformatics – Tisdall, J.D., First Edition O'Reilly Publishers.
2. Programming Perl – Wall, W., Christiansen, T. and Orwant, J., Third Edition, O'Reilly Publishers.
3. Java-2: The complete Reference – Naughton, P. and Schildt, H., Third Edition, McGraw Hill Publishers.
4. Computing Concepts with Java 2 Essentials – Horstmann, C.S., Second Edition, John Wiley Publishers.
5. Object Oriented Design and Applications – Benjamin, Cummings and Booch, G., Second Edition, Addison Wesley Publishers.

M.Sc. Bioinformatics (III Semester)

SPRBI 303: Genomics

UNIT-I

Genome Sequencing and Assembly: Genome organization, DNA sequencing, Genome Mapping - Physical mapping, Chromosome walking and Jumping. Large scale genome sequencing strategies - combinatorial approach, shot gun, hierarchical, high throughput sequencing, NGS technology, Fragment and map assembly, consensus problem, layout. Genome assembly and annotation, tools for genome assembly - Phred, Phrap, Consed. Metagenomics and their uses.

UNIT-II

Genome Databases and Comparative Genomics: Genome Databases at NCBI, EBI, TIGR, SANGER, Genome databases of virus, archeal, bacterial, fungal, plants and animals, Eukaryotic genomes with special reference to model organisms, Genome browsers. Basic concepts and applications of comparative genomics, Whole genome alignment - homology, paralogy, synteny, genome rearrangements and duplications, sorting by reversals, break point graphs, interleaving graphs and hurdles, duality theorem for genomic distance. Tools and Databases for comparative genomics.

UNIT-III

Structural Genomics: Gene annotation – Identification of exons, introns, promoters, enhancers, DNA motifs, splice sites, transcriptional and translational factors, repetitive elements, CpG islands. Gene networks – basics and computational models - Lambda receptor and lac operon, Application of methods to prokaryotic and eukaryotic genomes and interpretation of results.

UNIT-IV

Functional Genomics 1: Predicting gene function, Application of sequence based and structure-based approaches to assign gene functions – e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc, Use of various derived databases in function assignment, use of SNPs for identification of genetic traits, Gene/Protein function prediction using Machine learning tools: supervised/unsupervised learning, Neural network, SVM etc., Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps, gene expression profiling, identification of SNPs, SNP database (DbSNP), Role of SNP in Pharmacogenomics.

UNIT-V

Functional Genomics 2: SNP arrays, cDNA, EST, SAGE, MPSS, RNA expression and DNA microarray (Gene Expression Omnibus (GEO), ArrayExpress): database and basic tools, DNA microarray: design of microarray chip, understanding of microarray data, visualization of data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools (especially clustering approaches - K-means technique), algorithmic approaches to clustering gene expression data and applications, Methods and tools for identification of disease associated genes in molecular diagnostics (molecular markers).

Text Books:

1. Bioinformatics, Andrzej Polanski and Marek Kimmel, First Edition, Springer Publications.
2. Bioinformatics and Functional Genomics, Pevsner, J., John Wiley and Sons.
3. Principles of genome analysis and Genomics, Primrose, S.B. and Twyman, R.M., Third Edition, Blackwell Publishing Company.
4. Essential Bioinformatics, Jin xiong, Cambridge University Press.
5. Bioinformatics: Sequence and Genome Analysis, Mount, D., First Edition, Cold Spring Harbor Laboratory Press.
6. Introduction to Bioinformatics, Lesk, A.M., First Edition, Oxford University Press.
7. Essentials of Genomics and Bioinformatics, Sensen, C.W., First Edition, Wiley-VCH Publishers.

M.Sc. Bioinformatics (III Semester)

SPRBI 304: Proteomics

UNIT-I

Introduction to Proteomics: Need, Scope and Challenges, Strategies for protein separation – Preparation of extract, Measurement of protein quantity and enzyme activity. Protein purification by Precipitation, Adsorption – Gel permeation, HPLC, Ion-exchange, Affinity chromatography and Solution – Gel filtration, Preparative electrophoresis, Iso-electric focusing. Analysis for purity, Production of proteins – Small-scale and Large-scale.

UNIT-II

Structural Proteomics: Introduction, Techniques for solving protein structures - XRD, NMR, Mass spectroscopy – MALDI-TOF, ESI-MS, Tandem-MS, Methods to model protein structures – Primary, Secondary, Tertiary.

UNIT-III

Interaction Proteomics: Introduction, Principles of Protein-Protein Interaction, Library based methods for analysis of binary interactions - Phage interaction display and Yeast Two-Hybrid system, Protein-DNA interactions, Interaction maps.

UNIT-IV

Functional Proteomics: Protein sequence-structure-function relationship, Novel approaches to protein expression analysis – 2D-gel electrophoresis, DIGE and protein chip technology, Protein modifications in proteomics – Phosphoproteomics, Glycoproteomics, Ubiquitinomics, Applications of Proteomics.

UNIT-V

High-Throughput Proteomics (Case studies): Structural genomics of minimal organisms, Structural biology and genomics platform in Strasbourg, Bacterial structural genomics, Protein production and crystallization at NYSSGXRC, Pipeline for structural and functional characterization of macrophage proteins.

Text Books:

1. Principles of Proteomics – RM. Twyman, Spl. Indian Ed.
2. Bioinformatics: Genes, Proteins and Computers – Orengo, Jones and Thornton
3. Introduction to protein science – AM. Lesk, 2nd Ed.
4. Protein Purification: Principles and Practice – RK. Scopes, 3rd Ed.
5. Proteomics: From Protein sequence to Function – Pennington and Dunn
6. Structural Proteomics: High-throughput Methods – Kobe, Guss and Huber, Humana press.
7. DNA-Protein Interactions – Travers and Buckle, Indian Ed.

M.Sc. Bioinformatics (III Semester)

SPRBI 311: Molecular Modelling and Biocomputing Lab

1. Chemical Databases – Structure Representation and Storage in Different File Formats.
2. Generating 3D Representation from 2D Description of Small Molecules.
3. Computing Structural Properties of Small Molecules.
4. Molecular Graphics – Visualization of Macromolecules.
5. Protein Primary and Secondary Structure Analysis.
6. Protein Tertiary Structure Prediction by Homology Modeling.
7. Protein Tertiary Structure Prediction by Fold Recognition.
8. Protein Tertiary Structure Prediction by Ab-Initio.
9. Structure Alignment and Comparison.
10. Energy Evaluation and Geometry Optimization.
11. Polypeptide Conformation Analysis by Molecular Dynamics Simulation.
12. Polypeptide Conformation Analysis by Monte Carlo Simulation.
13. Program for accessing a sequence database using BioPerl.
14. Program to convert DNA sequence information to amino acid sequence using BioPerl.
15. Program for creating web-interface using BioJava.

M.Sc. Bioinformatics (III Semester)

SPRBI 312: Genomics and Proteomics Lab

1. Acquaintance with Genomic databases.
2. Characterization of genomes.
3. Prediction of ORF for genomic/DNA sequences from prokaryotic origin.
4. Prediction of ORF for genomic/DNA sequences from eukaryotic origin.
5. SNP analysis.
6. Contig analysis and assembly.
7. Genome assembly.
8. Isolation and purification of proteins.
9. Comparative analysis of protein samples using native and SDS-PAGE.
10. Demonstration of 2D-gel electrophoresis and analysis using 2DE databases.
11. Gene expression analysis using Real-time PCR.
12. Analysis of drug impurities using HPLC.
13. Prediction of post-translational modifications using various tools.
14. Predicting function of proteins using domain databases.
15. Identification of interacting partners using various Interaction maps.

M.Sc. Bioinformatics (IV Semester)

SPRBI 401: Drug Designing and Bioethics

UNIT-I

Introduction to Drugs: Drug discovery and Design – A historical outline, Leads and Analogues, Sources of leads and drugs, Methods and Routes of Administration, Classification of drugs, Drug action on receptors, enzymes and nucleic acids, ADMET properties.

UNIT-II

Drug Target Identification: Properties of Drug Targets, Target identification by *In vivo* and *In vitro* Methods – Haploinsufficiency Profiling, Chemogenomics approach, Chemical Proteomics, Signature Tag Mutagenesis, Gene knockout technology, Expression profiling. Target identification by *In silico* Methods - Genome analysis, Proteome analysis, Metabolome analysis, Microarray data analysis, Reverse docking, *In silico* knockouts, Grid technology for drug target discovery.

UNIT-III

Rational Drug Designing: Introduction, Target Identification, Lead Identification, Lead Optimization – Structure activity relationships (SAR), QSAR - Parameters, Descriptors, Analysis and Case study, 3D-QSAR, Toxicology studies, Preclinical and Clinical trails, FDA registration. Future developments in drug design.

UNIT-IV

Computational Drug Design: Computational Aspects of Library Design: Introduction, Virtual Screening, Computational filtering, Combinatorial library design, Computer Aided Drug Design – SBDD, LBDD, denovo, Molecular Docking – Docking problem, Docking process, Search algorithms, Scoring functions, Validation, Various methods of docking.

UNIT-V

Drug Action on Physiological Systems and Bioethics: Drugs affecting: Central Nervous System, Cardio Vascular System, Harmonal System, Immune System and Chemotherapeutic agents. Introduction to Bioethics, Biosafety guidelines and regulation, Intellectual Property Rights, Drug Patenting.

Text Books:

1. Medicinal Chemistry – Gareth Thomas, 2nd Ed.
2. Foye's Principles of Medicinal Chemistry – Lemke and Williams, 6th Ed.
3. Computatinal Drug Design – David C. Young.
4. Bioethics and Biosafety – M.K. Satish.

M.Sc. Bioinformatics (IV Semester)

SPRBI 421: Systems Biology

UNIT-I

Basics of Systems Biology: Introduction, basics and applications of systems biology. System Structure Identification, System Behavior Analysis, System Control, System Design, Measurement for Systems Biology, Genetic switch in Lambda phage, synthetic genetic switches, Modeling *E.coli* chemotaxis, Genetic oscillators.

UNIT-II

Modeling approaches in Systems Biology: Differential equation, Dynamic systems theory, Dealing with uncertainty. Importance of diffusion and gradients for cellular regulation, Models for Eukaryotic gradient sensing- Local excitation, Global inhibition model, Rapid Pole-to-pole oscillations in *E. coli*.

UNIT-III

Insilico cell simulation: Whole cell simulation, Virtual erythrocytes, Pathological analysis, Fermentation analysis, Minimal gene complement and Quorum sensing.

UNIT-IV

Metabolic systems biology: Basic principles and paradigm, Metabolome-Definition, measurement and uses, Analysis Methods: Bifurcation analysis, Metabolic control analysis, Flux balance analysis and Sensitivity analysis. Robustness of biological systems, Metabolic Engineering Systems.

UNIT-V

Network Biology: Introduction, Types of biological networks, Topology and analysis, Databases, Visualization tools, Construction and Modelling of networks and Applications.

Text Books:

1. Foundations of Systems Biology, Hiroaki Kitano, First Edition, The MIT Press.
2. Molecular Cell Biology of the Cell, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K and Walter, P, Fourth Edition, Taylor and Francis Group.

M.Sc. Bioinformatics (IV Semester)

SPRBI 422: Machine Learning and Implementation of Algorithms

UNIT-I

Introduction to Machine Learning: Definition, goals and applications of machine learning. Training data, concept representation, function approximation. Representing concepts as decision trees. Searching for simple trees and computational complexity. Ensembles.

UNIT-II

Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms - cross-validation, learning curves and statistical hypothesis testing. Artificial Neural Networks.

UNIT-III

Bayesian Learning and Instance-Based Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies. Constructing explicit generalizations. k-Nearest-neighbor algorithm.

UNIT-IV

Graph Algorithms: Graphs and digraphs. Shortest path problems. Complexity. Bellman's optimality principle. Dijkstra's algorithm. Shortest spanning trees. Kruskal's greedy algorithm. Prim's algorithm for shortest spanning trees. Networks. Flow augmenting paths. Ford-fulkerson algorithm for maximum flow. Bipartite matching.

UNIT-V

Text Processing: Pattern matching algorithms- Brute force, Boyer-Moore algorithm, KMP algorithm, tries, standard tries, compressed tries, suffix tries, text compression- Huffman coding algorithm.

Text Books:

1. Fundamentals of Data Structures – Horowitz E. and Sahani, S., 1st Ed.
2. Data structures and program design in C++ – Robert L. Kruse and Alexander J.Rybe, Prentice hall.

M.Sc. Bioinformatics (IV Semester)

SPRBI 423: Advanced Bioinformatics

UNIT-I

Database Design and Development: Identification of relevant problem, Procuring quality biological data, Data accuracy, Design and creating MySQL database, Parsing large-scale data into csv format using MySQL import tools, Importing multiple databases in bulk, Designing HTML and CSS course for web front end, Connecting front end and database with server side language or CGI script, Using different web technologies for client side for interaction interface.

UNIT-II

Scientific Data Visualization and Analysis: Visualization techniques, Software and Hardware standards, Interactive graphics, Viewing 2D and 3D data, Image processing and analysis, Animation, Visualizing genomic, metabolomics and proteomic data.

UNIT-III

Parasite Bioinformatics: Parasite Genome to Phenome databases, Parasite-omics data analysis for understanding parasite biology, Data mining tools for identification of parasite specific genes, resistant genes, multi-drug resistant genes, Resistant genes in plants, Host-Parasite vector interactions, Host-Pathogen, Host-Pathogen-Vector interactions.

UNIT-IV

Pharmaceutical Bioinformatics: Case studies- Integration of comparative genomics and molecular phylogeny to understand genes responsible for epidemiology, Screening of genes identified in the reported drug targets, Screening and modification of existing drugs or inhibitors.

UNIT-V

Emerging Areas in Bioinformatics: Neuroinformatics, Biodiversity informatics, Glyco-bioinformatics, Lipidomics, Agroinformatics, Biomedical informatics.

Text Books:

1. Biological sequence analysis, Durbin, Eddy, Krogh and Mitchison, Eighth Edition, Cambridge University Press.
2. Introduction to Bioinformatics, Lesk, A.M., First Edition, Oxford University Press.
3. Database System Concepts – Abraham, Korth and Sudarshan, 6th Ed.

M.Sc. Bioinformatics (IV Semester)

SPRBI 411: Drug Designing Lab

1. Target Prediction.
2. Binding Site Prediction.
3. Structure based Virtual Screening.
4. Ligand based Virtual Screening.
5. Protein-Ligand Docking.
6. Protein-Protein Docking.
7. Antigen-Antibody Docking.
8. Binding Free Energy Estimation.
9. QSAR Databases.
10. QSAR Model Generation.
11. ADME Toxicity Databases.
12. ADME Toxicity Prediction.
13. Determination of cytotoxicity by MTT assay.
14. Determination of genotoxicity by DNA laddering / Comet assay.
15. Demonstration of cell cycle arrest by drugs using Flow cytometer.

M.Sc. Bioinformatics (IV Semester)

SPRBI 413: Project Work and Seminar