

**Syllabus**  
**Masters Programme in Bioinformatics (Two Years)**  
**MMV, BHU**

**Semester 1**

- **Fundamentals of Programming Languages**
- **Essential Mathematics and Statistics I**
- **Fundamentals of Bioinformatics**
- **Biochemistry, Cell Biology and Molecular Genetics**

**Semester 2**

- **Data Structure and Algorithms**
- **Essential Mathematics and Statistics II**
- **Genomics & Proteomics**
- **Microbiology and Biotechnology**
- **Introduction to Bioinformatics (Minor elective: offered to other departments)**

**Semester 3**

- **Java Programming and Software Applications**
- **Structural Bioinformatics**
- **Database Management Systems**
- **Biodiversity, Ecological and Immuno-Informatics**
- **Project Conceptualization (Proposal, Design and Literature survey)**
- **Bioinformatics Applications to Protein Structure Analysis (Minor elective)**

**Semester 4**

- **Analytical Techniques & Chemoinformatics (Tools and Techniques)**
- **Introduction to System Biology/Soft Computing Techniques**
- **Seminar & Comprehensive Viva**
- **Project Work**

Basics of Computer and operating systems, Linux Operating system (vi editor, few basic commands like directory creation, deletion, permission setting etc. & programming of C).

Introduction to programming Languages and Paradigms, Data Representation, Data Abstraction, Structured Programming, Block Structuring.

Concepts of flowcharting and algorithm development.

Introduction to Programming Language C, Data Type, Operators and Expressions in C, Control and Repetitive Statements: IF-THEN-ELSE, SWITCH, WHILE, FOR, DO; Break and Continue Statements, Input and Output functions, Function and Program Structure in C, Parameter passing, Pointers, Arrays, Structures, C-Library.

Perl/Python for Bioinformatics: Basic concepts and application in biological sequence analysis.

### **Suggested Readings**

1. Sethi, R., 1996, Programming Languages, Addison-Wesley.
2. Appleby, D. and Vandkopple, J.J., 1991, Programming Languages, Tata McGraw-Hill.
3. Kernighan, B.W. and Ritchie, D.M., 2002 The C Programming Language, Prentice-Hall, India.
4. Gottfried, B.S., 1998 Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill
5. Schildt, H., 1987 C: The Complete Reference, Osborne/ TMH.
6. Tisdall, J.D. 2001 Beginning Perl for Bioinformatics. O'Reilly & Associates.
7. Schwartz R.L. and Phoenix T. 2011 Learning Perl 6<sup>th</sup> edition, O'Reilly SPD, Mumbai.
8. Siever 2000 Perl in a nutshell O'Reilly SPD, Mumbai
9. Model M.L. 2009 Bioinformatics Programming using Python: Practical Programming for Biological Data, O'Reilly.
10. Kinser J. 2008 Python for Bioinformatics, Series in Biomedical Informatics, Jones & Bartlett.

**MATHEMATICS**

Vectors: Vector algebra, Dot and Cross products.

Matrices; Algebra of Matrices, Transpose and inverse of matrices, Diagonalization of Matrices and Characteristic roots.

Differential Calculus: Definition of limits, basic properties of limits, continuous functions, classification of discontinuities, Differentiability.

Integral Calculus: Indefinite integration; integration by parts, integration by substitution methods; Definite integrals.

**STATISTICS**

Numerical description of data: Tabular, Graphical and Diagrammatic representation of data. Measures of Central tendency and Dispersion. Linear regression, Least square method, Karl Pearson correlation coefficient.

Probability Theory: Concept and definitions of Probability, addition and multiplication theorems, conditional probability, independent events, Statement of Bayes' theorem.

Random variables: Discrete and continuous random variables, cumulative density function, Probability density and mass functions, Joint, Marginal and Conditional distributions, mathematical expectation

Distributions: Binomial, Poisson, Normal distributions (Basic concepts and applications)

Basic ideas of Central Limit Theorem.

***Suggested Readings***

1. Ewens, W.J. and Grant, 2001. Statistical Methods in Bioinformatics: An Introduction, Springer-Verlag
2. Devore, J.L. 2002. Probability and Statistics 5<sup>th</sup> edition, Thomson Asia
4. Miller & Freund 2004 Probability and Statistics for Engineers, 7<sup>th</sup> Edition, Pearson's Education.
5. Chung, Kai Lai 2003 Elementary Probability Theory with Statistical Processes (Student Edition) Springer International
6. Feller, W. 2007 An Introduction to Probability Theory and its Applications, Wiley Eastern Limited.
7. Larson, H.J. 1982 Introduction to Probability Theory and Statistical Inference, John Wiley & Sons.
8. Goon, A.M., Gupta, M.K. and Dasgupta B. 1998 Fundamental of Statistics – Vol. 1, The World Press Pvt. Ltd.
9. Prasad, G.: Differential Calculus, Pothisala Publication
10. Prasad, G.: Integral Calculus, Pothisala Publication
11. Boas: Mathematical methods in the Physical Sciences, Wiley Publication.
12. Yule, G.U and Kendall, M.G.: An Introduction to the Theory of Statistics, Universal Book Stall (New Delhi).
13. Shanti Narayan, A text book of Vector Calculus, S Chand & company, New Delhi
14. D T Finbeiner, Introduction to Matrices and linear transformations, CBS publishers, Delhi

Definition and scope of Computational Biology and Bioinformatics.

**Major Bioinformatics Resources: NCBI, EBI, ExPaSy.**

**Pairwise sequence alignments:** Sequence similarity, identity, and homology. Global and local alignment, Dot plots for sequence comparison, Dynamic programming, BLAST and PSI-Blast, Application of Blast tool, Concept of Scoring matrix (PAM and BLOSUM).

**Multiple sequence alignments: Progressive Alignment** Algorithm (ClustalW), Application of multiple sequence alignment.

**Phylogenetic analysis:** Definition and description of phylogenetic trees, a primer on computational phylogenetic analysis.

Computational gene prediction methods, analysis of codon usage bias, computational prediction and analysis of regulatory sites.

Schematic representations and structure visualization of proteins structure, Protein DataBank.

### ***Suggested Readings***

1. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.
2. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers.
3. Baldi, P. and Brunak, S. 2001 Bioinformatics: The machine learning approach, The MIT Press.
4. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.
5. Lesk, A.M. 2005, 2<sup>nd</sup> edition, Introduction to Bioinformatics. Oxford University Press.
6. Fogel, G.B. and Corne, D.W., Evolutionary Computation in Bioinformatics.
7. Mount, D.W., Bioinformatics: 2001, Sequence and Genome Analysis. CSHL Press.
8. Durbin R., Eddy S., Krogh A. and Mithchison G. 2007 Biological Sequence Analysis, Cambridge University Press.

### **Biochemistry**

Principles of physical chemistry applied to biochemistry: chemical forces, hydrophilic and hydrophobic forces, van der Waal's forces, electrostatic interaction, hydrogen bonding.

Laws of thermodynamics, reversible and irreversible processes, polar molecules, molar refraction and polarization, dipole moment, non-covalent bonding in protein structure.

Proteins: A brief overview of amino acids, peptides and proteins; Structure of peptide bond, restricted rotation, cis-trans bonding.

Enzymes: Determination of  $V_{max}$  and  $K_m$  using Michaelis-Menten and Lineweaver-Burke plots, Mechanism of enzyme action (binding of substrate, lowering of activation energy), effect of factors on enzyme activity, basic concept of allosteric enzymes and inhibition.

### **Cell biology and Molecular Genetics**

Plasma membrane: dynamics of transport across membrane; mechanism of endocytosis and exocytosis.

Cell cycle and its regulation, Apoptosis.

Cell-Cell interaction: Cell adhesion molecules, Cellular junctions, Extracellular matrix.

Basic concept of signal transduction: Intracellular and cell surface receptor, Signaling via G-protein linked receptors, Enzyme-linked receptor signaling.

Nucleic acid: structure of different forms of DNA and RNA; Organization and packaging of genetic material of prokaryotes and eukaryotes ;DNA replication in prokaryotes and eukaryotes.

Gene expression: Transcription and Translation.Regulation of gene expression: transcriptional and post-transcriptional regulation in prokaryotes (*lac* and *trp* operons) and eukaryotes.

Mutation: types of mutation, mutagens, molecular mechanisms of mutation, site-directed mutagenesis, detection and isolation of mutants, transposons in mutation.

### **Suggested Readings**

1. Murray et. al., 2003 Harper's Illustrated Biochemistry. Prentice Hall Int.
2. Lehninger's Principles of Biochemistry 4<sup>th</sup> Edition, Macmillan UK.
3. Berg, J.M., Tymoczko, J.L., Stryer, L., 2002 Biochemistry 5<sup>th</sup> Edition. W.H. Freeman & Co. New York.
4. Zubay, Geoffrey L., 1998 Biochemistry 4<sup>th</sup> Edition. W. C. Brown Publishers, USA.
5. Lodish, H., Berk, A., Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., Zipurskey, S.L., Darnell, J., Molecular Cell Biology 5<sup>th</sup> Edition, Freeman. 2004
6. Voet, Donald & Voet, J.G., 2004 Biochemistry 3<sup>rd</sup> Edition. John Wiley & Sons Inc., USA.
7. Alberts et. al. 2009, Molecular Biology of the Cell. Garland.
8. Lewin 2009, Genes IX. Pearson.
9. Karp 2004, Cell and Molecular Biology. John Wiley.
10. Pollard & Earnshaw 2002, Cell Biology. Saunders.
11. Tobin & Morcel 1997, Asking about Cells. Saunders.
12. Watson et. al. 2004, Molecular Biology of the Gene. Pearson.
13. Atherly et. al. 1999, The Science of Genetics. Saunders.
14. Griffiths et. al. 2007, An Introduction to Genetic Analysis.
15. Russell 2002, Genetics. Benjamin.

**BIM200M INTRODUCTION TO BIOINFORMATICS**  
**(MINOR ELECTIVE : for students of other departments )**

**Credits 2**

Introduction and scope of Bioinformatics.

Major Biological Databases and Information Retrieval.

Homology Concept and Alignment of pairs of sequence, Global & Local Alignment,  
Basic Local Alignment Search Tool (BLAST), Other Blast options, PSI-BLAST.

Applications of BLAST tool.

Multiple sequence alignment and its applications.

Introduction to Computational Gene Prediction and Genome annotation

Basic concepts in Computational Phylogenetic Analysis

***Suggested Readings***

1. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.
2. Durbin R., Eddy S., Krogh A. and Mithchison G. 2007 Biological Sequence Analysis, Cambridge University Press.
3. Lesk, A.M. 2005, 2<sup>nd</sup> edition, Introduction to Bioinformatics. Oxford University Press.
4. Fogel, G.B. and Corne, D.W., 1997 Evolutionary Computation in Bioinformatics.
5. Rastogi et al 2003. Bioinformatics: Concepts, Skills and Applications. CBS
6. Rashidi and Buchler 2000. Bioinformatics Basics. CRC Press
7. Mount, D.W., Bioinformatics 2004. Sequence and Genome Analysis. CSHL Press

**Data Structure**

Basic Data Structures: Arrays, Linked Lists, Stack, Queue, Dequeue, Tree Heap, Hash Table and Collision resolution. Basic algorithms for Creation, Manipulation of Data Structures  
Internal Sorting Algorithms: Bubble, Heap, Quick Sort, Tape sorting and Merging.

**Algorithms**

Simple Algorithms, Analyzing Algorithms, Asymptotic Notation

Design Methods: General Consideration, Algorithm Design Paradigms and Representative Problems.

Divide and Conquer (Binary search, Merge Sort), Greedy Method (Minimal Spanning Tree).

Dynamic Programming (Chained Matrix Multiplication), Longest common subsequence,

Backtracking (8-queens problem), Branch and Bound (0/1 Knapsack Problem).

String Matching Problem, Brute Force Method, KMP Algorithm, Boyer-Moore Algorithm,

Approximate String matching.

***Suggested Readings***

1. Lipshutz and Pai, 2010 Data Structure (Outline Schaum Series), McGraw Hill, Indian edition.
2. Standish T. A., 1980 Data Structure Techniques, Addison-Wesley.
3. Salzberg, B., 1988, File Structures, Prentice-Hall.
4. Tharp, A.L., 1988, File Organization and Processing, John Wiley and Sons.
5. Aho, A., Hopcroft, J. and Ullman, J., The Design and Analysis of Computer Algorithms, Addison Wesley.
6. Horowitz E., Sahani, V S. Rajasekaran S. 1993 Fundamentals of Computer Algorithms. Galgotia, New Delhi.
7. Goodman S.E. and Hedetniemi S.T., Introduction to the Design and Analysis of Algorithms. McGraw Hill.
8. Brassard, G. and Bratley, P.1988 Algorithmics, Prentice-Hall India.
9. Basu, S.K., 2005 Design Methods and Analysis of Algorithms, Prentice Hall of India (Pvt) Ltd, New Delhi.

**A) MATHEMATICS**

Ordinary Differential Equations, Order and degree of Differential Equations, Initial and boundary conditions, Differential Equations of first order and first degree with constant coefficients.

Numerical Analysis: System of linear equations, Iterative methods for system of Linear equations, Numerical differentiation and integrations, Difference Equations.

Discrete Structures: Basic Concepts of Graphs and Trees, Adjacency and Incidence Matrices, Shortest Path, Planar Graphs, Graph Colouring, Applications of Graph theory to biological systems.

**B) STATISTICS**

Elementary idea of Point Estimation, Properties of good estimator.

Tests of hypothesis: Simple and Composite hypothesis, Errors in hypothesis testing, Power and Size of a test, p-value.

Test of significance based on  $t$ ,  $\chi^2$ , F and Z distributions.

Analysis of variance: One and two way classifications, Principles of Design of Experiments, completely Randomized and Randomized Block designs.

***Suggested Readings***

1. K. Rosen, Application of Discrete Mathematics, 5<sup>th</sup> Edition, New York, McGraw Hill.
2. S. Wiitala, Discrete Mathematics, A Unified Approach, McGraw Hill.
3. C.L. Liu, Elements of Discrete Mathematics, McGraw Hill .
4. Jain, Iyenger & Jain, Numerical Methods for Scientific & Engineering Computation 4<sup>th</sup> Edition. Wiley Eastern Limited.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, 3<sup>rd</sup> Edition. Prentice Hall
6. Jae K. Lee, 2012 Analysis. Statistical Bioinformatics, John Wiley & Sons Inc.
7. Goon, A.M., Gupta, M.K. and Dasgupta, B., 1998 Fundamental of Statistics – Vol. I & II, The World Press Pvt. Ltd.
8. Mood, A.M., Graybill, F.A and Boes, D., 1974 Introduction to the Theory of Statistics, McGraw-Hill
9. Yule, G.U. and Kendall M.G., 2000 An Introduction to the Theory of Statistics, Univ. Book Stall, New Delhi



Prokaryotic and Eukaryotic Genome: structure and organization.

Genome annotation; Gene networks (basic concepts).

Completed genomes and bioinformatics approaches to analyze the genomes of Viruses, Bacteria, Archaea, Nematode, Plant and Human.

Molecular evolution: Lateral or Horizontal Transfer among Genomes.

Transcriptome and Proteome- General Account; Tools of proteome analysis.

DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches).

Methods of Genome sequencing, EST, STS, GSS database and their generation

Whole Genome comparison.

### ***Suggested Readings***

1. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997 Proteome Research: New Frontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
2. Baxevanis, A. and Ouellette, F.B.F (Editors) 1998 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley and Sons, New York.
3. Dale and Schartz 2003 From Genes to Genomes. Humana.
4. Hawley and Mori 1999 The Human Genome. Academic.
5. Primrose and Twyman 2003 Principles of Genome Analysis & Genomics. Blackwell.
6. Pasternak 2000 An Introduction to Molecular Human Genetics. Fitzgerald.
7. Sudbery 2002 Human Molecular Genetics. Prentice Hall.
8. Liebler, D. 2002 Introduction to Proteomics: Tools for New Biology. Human Press Totowa.
9. Brown, T.A. 2002 Genome. John Wiley Press, US.
10. Campbell, A.M. & Heyer, L.J. 2002 Discovering Genomics, Proteomics and Bioinformatics. Benjamin/Cummings.
11. Jerome, P.E. 2002 Mathematics for Genome Analysis. Cambridge.

**A) Microbiology**

Brief account of microbial diversity; A general account of Archaea.

Modern approaches to bacterial taxonomy and classification.

Growth kinetics in batch cultures.

Organization of viral genomes, Lytic cycle in T- even phages, lysogeny and its regulation in lambda phage.

Genetic recombination in bacteria: Conjugation, Transformation and Transduction; Construction of genetic maps in bacteria.

**B) Biotechnology**

Tools & Techniques in recombinant DNA technology: Cloning vectors.

Polymerase chain reaction, DNA finger printing, DNA sequencing, Molecular markers.

Plant cell & tissue culture - General introduction, concept of cellular differentiation and totipotency, Gene transfer in plants; Application of recombinant DNA technology in crop improvement.

Basic techniques of animal cell and tissue culture, cell lines, pluripotent stem cell lines, stem cell culture, Gene transfer in animal systems, Molecular basis of human diseases and Gene therapy.

***Suggested Readings***

1. Prescott, L.M., Harley, J.P. and Klein, D.A. Microbiology. 8<sup>th</sup> Ed. 2010 WmC Brown Publishers, McGraw.
2. Madigan, M.T., Martinko, J.M. and Parker, J. Brocks. Biology of Micro-organism. 13<sup>th</sup> Ed. 2011, Prentice Hall.
3. Stanier, R.Y., Ingrahm, J.L. Wheelis, M.L. and Painter, P.R. General Microbiology 5th Ed. 1987, Macmillan.
4. Tortora, C.J., Funke, B.A. and Case, C.L. Microbiology An Introduction. 8th Ed. 2004. Pearson Education.
5. Lewin, R, Krebs, J. E., Goldstein, E. S. Genes X, 2011, Jones and Bartlett Publishers
5. Jackson, J.F. and Linskens 2003 Genetic Transformation of Plants. Springer.
6. Butler 2004 Animal Cell Culture and Technology.
7. Bhojwani, S.S. and Razdan, M.K, 2004 Plant Tissue Culture. Elsevier

**BIM300M BIOINFORMATICS APPLICATIONS TO PROTEIN STRUCTURE ANALYSIS**  
**(MINOR ELECTIVE : for students of other departments ) Credits 2**

Properties of amino acids and peptide bonds, Ramachandran Plot.

Motifs and Folds; Protein structure related databases, Protein DataBank format, Structure visualization of proteins.

Protein Fold Classification, Protein structure comparison, CATH and SCOP Databases.

Protein structure prediction methods. Homology modeling.

Molecular Docking and Drug design (Basic concepts).

***Suggested Reading***

1. Bourne, P.E., and Gu, J. 2009 Structural Bioinformatics (2<sup>nd</sup> edition), John Wiley & Sons, New York
2. Andreas D. Baxevanis, B. F. Francis Ouellette 2001 Bioinformatics: A Practical Guide to the Analysis of Genes, Wiley-Interscience
3. Lesk A. 2003 Introduction to Bioinformatics. Oxford
4. Mount 2003. Bioinformatics: Sequence and Genome Analysis. CBS
5. Attwood and Parry-Smith 2002. Introduction to Bioinformatics. Pearson
6. Barnes and Gray (ed) 2003. Bioinformatics for Geneticists. Wiley
7. Westhead et al 2003. Bioinformatics Instant Notes. Viva Books

DBMS Concepts: Data Abstraction, Database System Architecture, Schemas and Subschemas, Physical Data Organization - Hashed, Index File, B-tree.

Data Models: Data Modeling using entity relationship, Basic concepts of Hierarchical and Network Model.

Relational Model: Relational algebra and calculus, Functional dependencies, Decomposition.

Normal forms – first, second, third. BCNF.

Relational Query Language, Query Processing, Query Optimization- General Strategies of Optimization.

Basics concepts of SQL and SQL commands.

Introduction to Data mining: Classification, Clustering, Data Warehousing, Applications of Data Mining.

### ***Suggested Readings***

1. Date, C.J. Introduction to Database Systems (Vol I & II), 2004, 8th Edition. Addison-Wesley.
2. Ullman, J.D. 1989, Principles of Database and knowledge base Systems (Vol I & II), Computer Science Press New York.
3. Gio Wiederhold, 1997 Database Design, McGraw Hill.
4. Elmasri R. and Navathe S.B., 2007 Fundamentals of Database Systems. Fifth Edition. Pearson. Singh S.K., 2011 Database Systems- Concepts, Designs and Application. 2nd Edition. Pearson
5. Silberschatz A. Korth H. F. Sudarshan S., 2010 Database System Concepts. Sixth Edition. McGraw-Hill. Date K., Swamynathan S. 2012 An Introduction to Database Systems. Eight Edition. Pearson.

**JAVA**

Basics concepts of Object Oriented Programming.

An introduction to JAVA Programming, Data Types and Variables, Loops, Strings, Arrays, Using Methods, Classes, and Objects, Constructors, Function overloading, Inheritance, Packages, I/O in JAVA.

Applets Basics, Applet Life Cycles

AWT: Windows, Graphics and Text: AWT Classes, Window Fundamentals, Working With Frame Windows, Frame Window in an Applet, Exploring Text and Graphics, Controls, Layouts and Menus.

Distributed Computing, JAVA programming tools (Java Beans), Application in Bioinformatics.

**SOFTWARE APPLICATIONS**

Mathematical software package: MATLAB/SCILAB; or

Statistical Software package: R/SPSS.

***Suggeste Readings***

1. Laura Lemay and Rogers Cadenhead ,1999 Teach Yourself JAVA 2 in 21 days, Sams Division of Macmillan Computer Publishing.
2. Patrick Naughton and Herbertz Schildt, 1996 The Complete Reference JAVA 2 Tata Mcgraw-Hill.
3. Balaguruswamy E, 2009 Programming in JAVA 2, Tata Mcgraw-Hill, India.
4. Hortsman C. SW., 2005 JAVA Concepts 4<sup>th</sup> ed., John Wiley
5. Rambaugh James et al, 1997 Object Oriented Design and Modeling, Prentice-hall, India.
6. Russel J.P, 2001 JAVA Programming, Prentice Hall of India ,New Delhi
7. Schildt.H O' Neill J., 2002 JAVA 2 The Programmer's Reference, Tata McGraw Hill
8. Maindonald J. and Braun J. 2003 Statistical Analysis and Graphics using R, Cambridge University Press

Principles of Protein Structure and Classification: Properties of amino acids and peptide bonds, Ramachandran plot, Secondary structures, motifs and folds.

Protein Structure Visualization; tools and analysis of protein structures.

Protein Databank, Concepts of B-factor and R-factor.

Protein Structural Alignment and Superposition.

Protein Fold Classification, CATH, SCOP and FSSP Databases.

Secondary structure prediction methods.

Tertiary structure Prediction methods (Homology modeling, Fold recognition and ab-initio method).

Molecular dynamics and simulation study of protein, Force field concepts.

Molecular Docking (Basic concepts).

Drug target identification and Drug design.

### ***Suggested Readings***

1. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997 Proteome Research: New Frontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
2. Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Second Edition, Wiley.
3. Graur, D. and Li, W-H. 2000 Fundamentals of Molecular Evolution. Sinauer Ass., Mass., USA.
4. Tisdall, D., 2003 Mastering Perl for Bioinformatics. O'Reilly.
5. Lesk, A.M. 2005, 2nd edition, Introduction to Bioinformatics. Oxford University Press.
6. Fogel, G.B. and Corne, D.W., 2003 Evolutionary Computation in Bioinformatics.
7. Mount, D.W., Bioinformatics: 2004, Sequence and Genome Analysis. CSHL Press.
8. Phil Bourne and Helge Weissig, 2009 Structural Bioinformatics, Wiley-Blackwell
9. Leech Andrew, 2001 Molecular Modelling: Principles and applications (2nd Edition) Prentice Hall
10. Hinchliffe Alan, 2003 Molecular Modeling for Beginners, Wiley

## **BIM304                    BIODIVERSITY, ECOLOGICAL AND IMMUNO- INFORMATICS**

### **Credits 3**

#### **Biodiversity and Ecological Informatics**

Molecular Phylogenetics: Newick Format, Types of Data, Methods of Tree Reconstruction.

Systematic Databases.

Biodiversity and its Conservation, Hot Spots, Landscape Ecology, Bio-prospecting.

Biodiversity Informatics: Red Data Book Database, Online Biodiversity.

Basic Concepts of Ecosystem, Ecological Succession, Models of Succession . Major Biomes of the world.

Environmental Data and Information Management.

Basics of Remote Sensing, Platforms and Sensors, Visual and Digital Interpretation of Image, Vegetation Mapping by RS. Elements of GIS, Metadata.

#### **Immuno-informatics**

General properties of immune responses.

Cell and tissue/organs of immune system; Antigen; Structure and Functions of Antibodies; Major Histocompatibility Complex; Complement system.

Disorders of Immune System: Autoimmunity; Immuno-deficiencies and Hypersensitivity; Immuno-modulators; Immuno-informatics strategies for immune function and their role in personalized medicine.

#### ***Suggested Readings***

- 1.Recknagel F. 2002 Ecological Informatics: Understanding Ecology by Biologically- Inspired Computation, Springer, New York.
2. Odum E.P. 1983 Basic Ecology. Saunders International Edition, Japan.
3. Atkinson P.M. and Tate, N.J.(Eds.) 1999 Advances in Remote Sensing and GIS Analysis,Wiley, NY
4. Gunther O. 1998 Environmental Information Systems, Springer.
5. Pankhurst R.J. 1981 Practical Taxonomic Computing, Cambridge University Press, Cambridge.
6. Judd W.S., Campbell C.S., Kellogg E.A.,Stevens P.F. and Donoghue M.J. 2002 Plant Systematics: A Phylogenetic Approach, 2<sup>nd</sup> Ed., Sinauer Associates, Inc., Sunderland, USA.

**A**

Basic principles of UV, Visible and IR Spectroscopy and their application in structure analysis. Fluorescence spectroscopy and application of spectroscopy to bio-molecules.

Basic principles of NMR technique for structure determination. Elementary idea of spin-spin coupling and chemical shift as applied to molecular NMR spectra.

Mass Spectroscopy: Basic concept of principle and working of mass spectrometers. Recent improvements in the technique for application in biological sample; medicine and protein characterization.

X-Rays- Basic principles & applications. Bragg's law and diffraction. Diffraction from liquid, amorphous and crystalline sample. Elementary ideas of X-Ray diffraction and X-ray diffractometer. Electron diffraction. Comparison between X-ray and electron diffraction.

**B**

Principle and application of ultra centrifugation, electrophoresis and chromatography.

Biosensors. Types of biosensors, working principles, electrochemical biosensors. Immobilization methods. Application and advances in biosensors.

Introduction and scope of Chemo-informatics, representation of chemical compounds: Line notation, Wiswesser, ROSDAL, The SMILES coding, Sybyl Line Notation.

Molecular Modeling: modeling of small molecules.

Quantity Structure Activity Relationships (QSAR) – basic concept. Application to drug designing.

***Suggested Readings***

1. H.H. Willard, L. L. Merrit, and J.A. Dean, 1986 Instrumental Methods of Analysis 6<sup>th</sup> Edition, CBS Publishers & Distributors, Shahdara, Delhi
2. G.D. Chistian, 1986 4<sup>th</sup> Edition 1986. Analytical Chemistry,, John Wiley & Sons, New York
3. Bujnicki, J.M. 2004. Practical Bioinformatics Series: Nucleic Acids & Molecular Biology Vol. 15, Springer.
4. Stan Tsai, C. An Introduction to Computational Biochemistry 1<sup>st</sup> Edition. John Wiley & Sons., Inc.
5. Bovey, F.A., Mirau, P.A. and Gutowsky, H.S., Nuclear Magnetic Resonance Spectroscopy (2<sup>nd</sup> Edition). Academic Press.
6. Jan Drenth Principles of Protein X-ray Crystallography Springer Advanced Texts in Chemistry, Springer-Verlag Telos.
7. Yadav, L.D.S., 2005 Organic Spectroscopy 1<sup>st</sup> Edition, Springer.  
Hollas, J.M., High Resolution Spectroscopy 2<sup>nd</sup> Edition, John Wiley & Sons.
8. Tudor, I.O., Mannhold, R. Kubinyi, H. and Folkers, G. Chemo Informatics in Drug Discovery: Methods and Principles in Medicinal Chemistry
9. Gasteiger, 2003 Chemo-informatics A Text Book.
10. Hallet, F.R., Stinson, R.H., Speight, P.A. and Graham, W.G., 2002 Physics for the Biological Sciences, Toronto: Nelson Canada.
11. Westhead, D.R., Parish J.H and Twyman, R.M., 2003 Bioinformatics (Instant notes Chemistry series), B.D. Hames, U.K
12. Elements of X-Ray diffraction 2010. B.D. Cullity & S.R. Stock, Addison Wesley
13. X-Ray diffraction A practical approach C. Suryanayava, M. Grant Norton, Springer 1998
14. Principles of Mass Spectrometry Applied to Biomelecules, 2006 Julia Laskiu & Chava Lifshitz, Ed. John Wiley & Sons.



Basic concepts and perspectives of Systems Biology.

Introduction to Modeling in Systems Biology and some biological models: Population Ecology and Epidemiological models.

Biological Networks: Representation, Network visualization and structural analysis of Biological Networks – Metabolic Networks; Transcription Regulation Networks and Protein-protein Interaction Networks.

Metabolome, Interactome and Transcriptome (basic concepts), Protein- Protein Interaction Databases, Systems Biology databases. Software for Systems Biology.

### ***Suggested Readings***

1. Kitano H. (ed.), 2001 Foundations of Systems Biology. MIT Press.
2. Bock G. and Goode J.A. (ed.), 2002 In Silico Simulation of Biological Processes, Novartis Foundation Symposium, John Wiley & Sons.
3. Klipp E., Herwig R., Kowald A., Wierling C., and Lehrach H., 2005 Systems Biology in Practice, Wiley-VCH.
4. Sneppen K. and Zocchi G., 2005 Physics in Molecular Biology, Cambridge University Press.
5. Noble D., The Music of Life, 2006 Biology Beyond the Genome Oxford University Press.
6. Szallasi T., Stelling J. and Periwé V. (ed.), 2006 System Modeling in Cellular Biology: From Concepts to Nuts and Bolts (Hardcover), MIT Press.
7. Palsson B., 2006 Systems Biology - Properties of Reconstructed Networks, Cambridge University Press.
8. Kaneko K., 2006 Life: An Introduction to Complex Systems Biology, Springer
9. Alon U., 2006 An Introduction to Systems Biology: Design Principles of Biological Circuits, CRC.