DEPARTMENT OF COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

UNIVERSITY OF KERALA

MSc. PROGRAMME IN COMPUTATIONAL BIOLOGY

SYLLABUS

Under Credit and Semester System w. e. f. 2017 Admissions

DEPARTMENT OF COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

UNIVERSITY OF KERALA

MSc. PROGRAMME IN COMPUTATIONAL BIOLOGY

SYLLABUS

PROGRAMME OBJECTIVES

- Aims to equip students with basic computational and mathematical skill
- To impart basic life science knowledge
- To acquire advanced computational and modelling skills required to address problems of life sciences for computational perspectives

MSc. Syllabus of the Programme			
Semester	**Course Code**	**Name of the course**	**Number of Credits**
I	Core Courses		
	BIN-C-411	Introduction to Life Sciences & Bioinformatics	4
	BIN-C-412	Applied Mathematics	4
	BIN-C-413	Web programming and Databases	4
	BIN-C-414	Bioinformatics Lab I	3
	Internal Electives		
	BIN-E-415 (i)	Python Programming (E)	2
	BIN-E-415 (ii)	Seminar I (E)	2
	BIN-E-415 (iii)	Programming in R (E)	2
	BIN-E-415 (iv)	Communication skill in English (Elective skill course)	2
II	Core Courses		
	BIN-C-421	Creativity, Research & Knowledge Management	4
	BIN-C-422	Fundamentals of Molecular Biology	4
	BIN-C-423	Computational Genomics	4
	BIN-C-424	Bioinformatics Lab II	3
	Internal Electives		
	BIN-E-425 (i)	Perl and BioPerl (E)	4
	BIN-E-425 (ii)	Case Study (E)	2
	BIN-E-425 (iii)	Android App Development for Bioinformatics(E)	2
	BIN-E-425 (iv)	Negotiated Studies(E)	2
	BIN-E-425 (v)	Communication skill in English (Elective skill course)	2
III	Core Courses		
	BIN-C-431	Proteomics and CADD	4
	BIN-C-432	Phylogenetics	4
	BIN-C-433	Advanced Topics in Computational Biology	4
	BIN-C-434	Bioinformatics Lab III	3
	Internal Electives		
	BIN-E-435 (i)	DSP and Soft Computing (E)	4
	BIN-E-435 (ii)	Mini Project (E)	2
	BIN-E-435 (iii)	Big Data Bioinformatics (E)	3
IV	Internal Electives		
	BIN-E-441 (i)	Seminar II (E)	2
	BIN-E-441 (ii)	Research Proposal Preparation (E)	2
	Core Courses		
	BIN-D-442	Project and Viva Voce	15
Extra Departmental Elective Course			
I	BIN-X-411	Introductory Bioinformatics	2
II	BIN-X-421		
III	BIN-X-431		

Semester : I
Course Code : BIN-C-411
Course Title : INTRODUCTION TO LIFE SCIENCES & BIOINFORMATICS
Credits : 4

AIM: To give a bird's eye view of life sciences and to introduce basics of Bioinformatics.

COURSE OBJECTIVES:

- To introduce the nature and scope of life sciences
- To give an overview about basic molecular Biology concept
- To understand the basic Bioinformatics and algorithms used in Computational Biology

COURSE CONTENT

Module I: Nature and scope of life science: Branches of life sciences, Characteristics of life, Levels of Organization, Origin of life, Biochemical evolution- evolution of Proteins and Nucleotide.

Module II: Cell Biology: The cell as basic unit of life- Prokaryotic cell and Eukaryotic cell, Cell Structure and Function- cell membrane, cell organelles, Cell Division; Mitosis & Meiosis.

Module III: Cell Energetics: Laws of Thermodynamics, Photosynthesis, Anaerobic & aerobic respiration, Structure and function of mitochondria, respiratory pathways: Glycolysis, Kreb's Cycle, Electron transport chain.

Module IV: Chromosome-Genome-Genes-Databases: Bio-molecules- DNA, RNA, Protein and amino acids, Chargaff's Rules, Codon bias, GC content. Central Dogma: Replication, Transcription, Translation, Post transcriptional & post translational modifications, RNA processing, RNA splicing and RNA editing. Sense/coding and anti-sense/template strands, Genetic code, wobble hypothesis. Introduction to DNA and Protein sequencing, Human Genome Project, Bioinformatics databases, Type of databases, Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, Gene Bank, DDBJ; Secondary nucleotide sequence databases.

Module V: Proteins and Databases: Protein structure and function, Protein Primary structure, Amino acid residues, Secondary, Tertiary, Quaternary Structure of Protein, Protein sequence databases- SwissProt/ TrEMBL, PIR, Sequence motif databases -Pfam, PROSITE, Protein structure databases, Protein Data Bank-SCOP, CATH, KEGG, Chembank, Sequence, structure and function relationship.

Module VI: Introduction to Computational Biology and Bioinformatics: Nature and scope of Computational Biology and Bioinformatics, Basic algorithms in Computational Biology, Introduction to sequence alignment (only general ideas, not algorithm) - Local and global, pair wise and multiple, BLAST.

REFERENCES:

- Becker, W. M., Kleinsmith, L. J., Hardin, J., & Raasch, J. (2003). The world of the cell (Vol. 6). San Francisco: Benjamin Cummings.
- Berg, J. M., Tymoczko, J. L., & Stryer, L. (2002). Biochemistry, ; W. H.
- Claverie,J.,M., Notredame,C.(2003).Bioinformatics: A Beginner's Guide. Wiley India Pvt. Limited.
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- Karp, G. (2009). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.
- Kuriyan, J., Konforti, B., & Wemmer, D. (2012). The molecules of life: Physical and chemical principles. Garland Science.
- Lewin, B. (2011). Lewin's genes X (Vol. 10). J. Krebs, S. T. Kilpatrick, & E. S. Goldstein (Eds.). Jones & Bartlett Learning.
- Lodish, H. (2008). Molecular cell biology. Macmillan.
- Mason, K. A., Losos, J. B., Singer, S. R., & Peter, H. Raven, and George B. Johnson.(2011). Biology.
- Misener, S., Krawetz, S.A.(1999). Bioinformatics Methods and Protocols. Humana Press.
- Moody, G. (2004). Digital code of life: how bioinformatics is revolutionizing science, medicine, and business. John Wiley & Sons.
- Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry. Macmillan.
- Old, R. W., & Primrose, S. B. (1981). Principles of gene manipulation: an introduction to genetic engineering (Vol. 2). Univ of California Press.
- Rastogi, S. C. (2005). Cell biology. New Age International.
- Reece, J. B., Taylor, M. R., Simon, E. J., & Dickey, J. (2009). Biology: concepts & connections (Vol. 3, p. 2). Pearson/Benjamin Cummings.
- Wünschiers, R. (2004). Computational Biology: Unix/Linux, data processing and programming. Springer.
- Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. Garland Science.

ADDITIONAL REFERENCES:

- Bioinformatics: introduction and method, conducted by Peking University. https://www.coursera.org/course/pkubioinfo
- Bioinformatics: life sciences on your computer, conducted by Johns Hopkins. University. https://www.coursera.org/course/bioinform
- Emergence of life, conducted by University of Illinois Urbana-Champaign campus. https://www.coursera.org/course/emergenceoflife
- Genes and the human condition (from behavior to biotechnology), conducted by University of Maryland. https://www. coursera.org/course/genes.

- Introduction to biology - the secret of life, conducted by Massachusetts Institute of Technology. https://www.edx.org/course/mitx/mitx-7-00x-introduction-biology-secret-1768
- Origins - formation of the universe, solar system, earth and life, conducted by University of Copenhagen. https://www.coursera.org/course/origins
- Preparation for introductory biology: DNA to organisms, conducted by University of California. https: //www.coursera.org/course/introbiology.

Semester : I
Course Code : BIN-C-412
Course Title : APPLIED MATHEMATICS
Credits : 4

AIM: The course serves to provide basic overview of Mathematical concepts that may be used in Computational Biology.

COURSE OBJECTIVES:

- To revive basic concepts in mathematics studied so far
- To reinforce fundamental concepts of higher mathematics through Matlab/Scilab exercises
- To introduce basic algebra and calculus
- To introduce probability and allied areas
- To understand the use of statistical methods in analyzing biological data

COURSE CONTENT

Module I: Introductory concepts and Scilab: Review of basic mathematics: Co-ordinate geometry, equations of line, circle and sphere; Trigonometric functions, graphs of functions, types of functions: linear functions, Inverse Functions, Exponentials and logs; Graphical solution of equations of the form f(x) = 0. Scilab, Basic environment, data types, variables, operators, programming, built-in function and user defined function.

Module II: Vectors and Matrices: Vectors & Matrices: Scalars & Vectors, addition, subtraction, dot, cross & scalar triple products; Matrices: types, addition, subtraction, multiplication, transpose & inverse (general idea only), determinants, solutions of simultaneous equations using matrices. Transformation matrices for scaling, translation, rotation and reflection; Matrix processing in Matlab/Scilab.

Module III: Calculus: Limits & Derivatives: Limits, continuity, derivative as rate of change. Graphical treatment of derivative, maxima and minima, Newton's methods, numerical differentiation. Integrals: graphical treatment, Integrating simple expressions, Definite and indefinite integrals, The area under a curve, Numerical integration-Simpson's rule, simple symbolic integration. Introduction to Differential equations Scilab/MATLAB implementation of Newton's method and Simpsons rule.

Module IV: Set theory: permutation, combination: Set theory, sets, elements, set operation, finite &countable sets, counting, factorial, permutation, combination, binomial coefficients.

Module V: Probability and Statistics: Basic concepts; sample space & events, laws of probability, conditional probability: Baye's theorem, Random variables: probability distribution, binomial, Poisson, normal't' etc.; Sampling; Markov's processes.

Module VI: **Applied Statistics**: Scope of statistical methods, frequency distribution, measures of central tendency: mean, median, mode, geometric mean, harmonic mean, percentile; measures of dispersion: range, mean deviation, variance & standard deviation; linear regression & correlation; Chi- square test; ANOVA.

REFERENCES:

- Aitken, M., Broadhurst, B., & Hladky, S. (2008). Mathematics for biological scientists. New York [etc.]: Garland Science [etc.].
- Isaev, A. (2006). Introduction to mathematical methods in bioinformatics. Springer.
- Lipschutz, S., & Schiller, J. J. (1998). Schaum's Outline of Theory and Problems of Introduction to probability and statistics. McGraw-Hill.
- Olive, J. (2000). Maths: A Self-study Guide. Cambridge University Press.
- Ramachandran, H., Nair, A.S.(2012). (Scilab: Free Software to Matlab). S. Chand Limited.
- Russell, B. (1903). The principles of mathematics (Vol. 1, p. 173). Cambridge, UP: Cambridge.
- Stewart, J. (2008). Calculus Early Transcendentals, 6e. Bob Pirtle, Belmont, CA 94002USA, 883-886.
- Sundar Rao, P. S. S., & Richard, J. (1996). An introduction to biostatistics. New Delhi. Prentice-Hall India, 19, 135-52.

ADDITIONAL REFERENCES:

- Allman, E. S., & Rhodes, J. A. (2004). Mathematical models in biology: an introduction. Cambridge University Press.
- Etter, D. M., Hull, D., & Kuncicky, D. C. (2004). Introduction to MATLAB 6.
- Ewens, W. J., & Grant, G. R. (2005). Statistical methods in bioinformatics: an introduction (Vol. 746867830). New York: Springer.
- Issac, R. (1995). The Pleasures of Probability. Springer Verlag.
- Pratap, R. (2009). Getting started with MATLAB: a quick introduction for scientists and engineers. Oxford University Press, Inc.
- Strogatz, S. H. (2012). The Joy of x: a Guided Tour of Math, from one to Infinity. Houghton Mifflin Harcourt.
- Effective Thinking through Mathematics, conducted by The University of Texas.
- AP® Statistics, conducted by The Tennessee Board of Regents. https://www.edx. org/course/tennessee-board-regents/tennessee-board-regents-statx-apr-3541
- Pre-University Calculus, conducted by Delft University of Technology. https://www.edx.org/course/delftx/delftx-calc001x-pre-university-calculus-3806

- Introduction to Probability -The Science of Uncertainty, conducted by Massachusetts Institute of Technology. https://www.edx.org/course/mitx/mitx-6-041x-introduction-probability-1296.
- Combinatorial mathematics, conducted by Tsinghua University. https://www.edx.org/course/tsinghuax/tsinghuax-60240013x-combinatorial-3771
- Foundations of data analysis, conducted by The University of Texas. https://www.edx.org/course/utaustinx/utaustinx-ut-7-01x-foundations-data-2641
- https://www.edx.org/course/utaustinx/utaustinx-ut-9-01x-effective-thinking-1178
- Linear Algebra - foundations to frontiers, conducted by The University of Texas.https://www.edx.org/course/utaustinx/utaustinx-ut-5-02x-linear-algebra-4491
- http://www.mathtutor.ac.uk/
- http://www.scilab.org/

Semester : I
Course Code : BIN -C-413
Course Title : WEB PROGRAMMING AND DATABASES
Credits : 4

AIM: This course gives an introduction about databases and highlights its advantages over traditional file system.

COURSE OBJECTIVES:

- To introduce basic theory and practice in database approach
- To introduce ER modeling and ER diagrams
- To give an overview of relational databases and normalization
- Develop moderate skills in PHP, MySQL and advanced web programming languages

COURSE CONTENT

Module I: Introduction to databases: Traditional file system, data and need for information, database approach, data models, schemas and instances, Data independence, 3 schema architecture, Database languages, Database users, Classification of database systems, E-R modeling, Attributes and keys, E-R diagrams**.**

Module II: Introduction to Relational model: Basic concepts: Domains Attributes, keys, tuples, Relations, Relational database schemas, relational Algebra operations, SQL in queries, views

Module III: Relational Calculus and Normalization: Overview of relational calculus, Conceptual design of relational database, Normalization theory, Functional dependencies, Lossless decomposition of relations, First, Second, Third and Boyce-Codd normal forms.

Module IV: Introduction to Data Mining: Basics of data mining, Related concepts, Knowledge Discovery, KDD Process, Data mining techniques: statistical methods, similarity measures and decision trees. Classification - Overview and Techniques: regression, Bayesian classification, distance based and decision tree based algorithm. Clustering - Overview and Techniques: hierarchical algorithm, partitional algorithms- k means clustering. Association rules - support and confidence, APRIORI algorithm

Module V: Web Mining: Introduction, Web Content Mining, Web Structure Mining, Web Usage Mining, Introduction to PHP, Introduction to MySQL, integration of PHP with database, introduction to XML, introduction to LAMP, examples for small database management project.

Module VI: (Flexi module- Only for Internal Assessment. Lecturers may expand and/ or interpret the *syllabus to update it or suit the particular cohort in any way****)*:** Familiarization of Ubuntu, New open-source mobile platform- Android and Firefox OS, HTML5, CSS3 and JavaScript, Introduction to JQUERY.

REFERENCES:

- Connolly, T. M., & Begg, C. E. (2005). Database systems: a practical approach to design, implementation, and management. Pearson Education.
- Dunham, M. H. (2006). Data mining: Introductory and advanced topics. Pearson Education India.
- Elmasri, R. (2008). Fundamentals of database systems. Pearson Education India.
- Han, J., Kamber, M., & Pei, J. (2006). Data Mining: Concepts and Techniques, (The Morgan Kaufmann Series in Data Management Systems).
- Leon, A., & Leon, M. (2010). Database management systems. Vikas Publishing House Pvt. Limited.
- Shinghal, R. (2012). Introduction to fuzzy logic. PHI Learning Pvt. Ltd.
- Silberschatz, A., Korth, H. F., & Sudarshan, S. (1997). Database system concepts (Vol. 4). New York: McGraw-Hill.

ADDITIONAL REFERENCES:

- Data structures and algorithms, conducted by Peking University. https://www.edx.org/course/pekingx/pekingx-04830050-2x-shu-ju-jie-gou-yu-4611
- Data structures, conducted by Tsinghua University. https://www.edx.org/course/tsinghuax /tsinghuax-30240184x-data-structures-shu-3416
- Fundamentals of programming**,** conducted by Peking University. https://www. edx.org/course/pekingx/pekingx-532001x-cheng-xu-she-ji-ji-chu-2046
- Introduction to computational thinking and data science, conducted by Massachusetts Institute of Technology. https://www.edx.org/course/mitx/mitx-6-00-2x-introductioncomputational-2836#.VENO_fmUf0k
- CSS: http://www.w3schools.com/css/
- HTML: http://www.w3schools.com/html/
- jQuery: http://www.w3schools.com/jquery/
- PHP: http://www.w3schools.com/php/

Semester : I
Course Code : BIN-C-414
Course Title : BIOINFORMATICS LAB I
Credits : 3

AIM: To provide hands on experiences covering the course BIN-C-411 of semester I.

COURSE OBJECTIVES:

- To familiarize students with basic wet laboratory concepts and techniques by directly carrying out the experiments.
- To give an overview about basic Microbiology concept
- To understand the basic Bioinformatics databases and algorithms used in Computational Biology

COURSE CONTENT

Module I: Laboratory safety guidelines, equipment handling, Preparation of buffers, reagents and media: simple media, special media.

Module II: Basic experimental concepts in Microbiology, Sterilization: dry heat, moist heat, Radiation, chemical treatment, Isolation of bacteria from different samples: soil, water and air, Microscopic examination of bacteria by simple and differential staining, bacterial colony characterization, Biochemical characterization of bacterial colonies, Antibiotic sensitivity test, Bacterial growth curve. Decontamination of microbial culture

Module III: Differential staining of blood, Blood typing, chromosome preparation: mitosis –Onion root tip

Module IV: Facilitating access from various Bioinformatics databases: NCBI, PDB, SWISS PROT, Pfam etc., and pairwise sequence alignment using BLAST.

Module V: Database creation and management using PHP-MySQL, Writing programs using python features including functions, string handling as well as object oriented features, Data analysis using R package.

Module VI: Experiments in basic bioinformatics tools

REFERENCES:

- Aneja K.R. (2014). Laboratory manual of Microbiology and Biotechnology, Medtec
- Claverie, J. M., & Notredame, C. (2011). Bioinformatics for dummies. John Wiley & Sons.
- Jayaraman, J. (1981). Laboratory manual in biochemistry. Wiley Eastern
- Miller, J. H. (1992). Experiments in molecular genetics.
- Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: a laboratory manual.

- Winfrey, M. R., Rott, M. A., & Wortman, A. T. (1997). Unraveling DNA: Molecular biology for the laboratory (pp. 73-80). New York (NY): Prentice-Hall.

ADDITIONAL REFERENCES:

- http://www.ncbi.nlm.nih.gov/education/tutorials/
- http://www.ncbi.nlm.nih.gov/books/NBK143764/

Semester : I
Course Code : BIN -E-415(i)
Course Title : PYTHON PROGRAMMING
Credits : 2

AIM: The course is aimed at providing moderate programming skills in Python programming language to enable students to write their own Python programs for solving common problems in bioinformatics.

COURSE OBJECTIVES:

- To provide the basics of Python programming language components
- To understand the advanced concepts including object oriented concepts, CGI scripting and database interaction

COURSE CONTENT

Module I: Introduction to Python: Introductory Remarks about Python, Pros & cons, A Brief History of Python, Python Versions, Installing Python, Environment Variables, Executing Python from the Command Line, IDLE, Editing Python Files, Getting Help, Dynamic Types, Python Reserved Words, Naming Conventions, Basic Python Syntax- Comments, String Values, String Operations, The format Method, String Slices, String Operators, Numeric Data Types, Conversions, Simple Input and Output, The print Function

Module II: Language Components: Control Flow and Syntax, Indenting, The if Statement, Relational Operators, Logical Operators, True or False, Bit Wise Operators, The while Loop, break and continue, The for Loop, Collections- Lists, Tuples, Sets, Dictionaries, Sorting Dictionaries, Copying Collections

Module III: Functions- Defining Your Own Functions, Parameters, Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function, Variable Number of Arguments, Scope, User defined Functions, Mapping Functions in a Dictionary, Lambda, Closures, Modules, Libraries, Iterators, Generators, Text, Binary Handling: iteration protocol, iterable objects, generators and generator expressions, data processing pipelines

Module IV: Classes in Python: Principles of Object Orientation, Creating Classes, Instance Methods, File Organization, Special Methods, Class Variables, Inheritance, Polymorphism, Type Identification, Custom Exception Classes, Class Documentation – pydoc, Exceptions- Errors, Run Time Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions, Writing new Exception Classes, Input and Output- Data Streams, Creating Data Streams, Access Modes, Writing & Reading From/To a File, Using Pipes as Data Streams, Handling IO Exceptions

Module V: String Processing: Regular Expressions, Introduction, Simple Character Matches, Special Characters, Character Classes, Quantifiers, The Dot Character, Greedy Matches, Grouping,

Matching at Beginning or End, Match Objects, Substituting, Splitting a String, Compiling Regular Expressions, Flags; Python & CGI; Python Interacting with databases

Module VI (**Flexi module-** Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way): Python interaction with other programming languages, support for common data interchange formats (e.g., XML), network programming, accessing C code, COM extensions; Jython and IronPython

REFERENCES:

- Beazley, D. M. (2009).Python essential reference. Addison-Wesley Professional.
- Barry, P. (2010). Head First Python. "O'Reilly Media, Inc.".
- Punch, W. F., & Enbody, R. (2010). The practice of computing using python. Addison-Wesley Publishing Company.
- Mark, S. (2009). Programming in Python 3. Pearson Education India.
- Lutz, M. (2013). Learning python. "O'Reilly Media, Inc.".
- Turnquist, G. L. (2011). Python Testing Cookbook. Packt Publishing Ltd.
- Arbuckle, D. (2010). Python Testing: Beginner's Guide. Packt Publishing Ltd.
- Wentworth, P., Elkner, J., Downey, A. B., Meyers, C., & List, C. (2011). How to think like a computer scientist.

ADDITIONAL REFERENCES:

- An introduction to interactive programming in Python, conducted by Rice University https://www.coursera.org/course/interactivepython.
- Programming for everybody (Python), conducted by University of Michigan. https:// www.coursera.org/course/pythonlearn.

Semester : I
Course Code : BIN-E-415(ii)
Course Title : SEMINAR I
Credits : 2

AIM: To give an opportunity for students to practice technical communication.

COURSE OBJECTIVE:

- To give an opportunity for self-study of a selected topic.
- To practice serious focused reading and assimilation of science and technology literature.
- To enhance the skill for scientific writing of a Research topic in research paper format in Bioinformatics (OUP) style.
- To equip the students with formal presentation.

Semester : I
Course Code : BIN -E-415(iii)
Course Title : PROGRAMMING IN R
Credits : 2

AIM: To impart moderate programming skills in R.

COURSE OBJECTIVES:

- To give an in-depth introduction to the computing environment of R and the basic R programming concepts
- To facilitate the practical skills to import and export data sets from various file types
- To prepare the students to develop practical applications of R programming

COURSE CONTENT

Module I: Introduction: R environment; Why R? R for Computational Biology and Bioinformatics; Installing R; R- GUI and IDE; Running R. Programming with R: R as a deluxe calculator, Objects: creating objects and assigning values, Types of objects: vector, matrix, array, factor, list, data frames and functions; Data structures.

Module II: Control Statements in R: if, for, repeat, while; Functions- user defined function and built –in functions. Working with data sets: Reading and writing data from files: read.table, write.table, read.csv, write.csv, readFasta, writeFasta. File manipulation in R: Opening a file, creating a file, editing a file, renaming a file, removing a file.

Module III: Graphics in R: Introduction to graphics package: scatterplot, boxplot, barplot, plotting time series, plotting categorical data, basic graphics functions-high level functions and low-level functions, saving graphical output.

Module IV: Statistics using R: Basic statistical operations: mean, median, range, minima and maxima, variance, standard deviation, correlation coefficient, covariance, R for statistical applications.

Module V: (Flexi module- Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way.**): Packages in R:** CRAN, Installing packages, loading packages, unloading packages, listing packages. Bioconductor - overview, features, overview of packages in Bioconductor.

REFERENCES:

- Adler, J. (2010). R in a nutshell: A desktop quick reference. "O'Reilly Media, Inc.".
- Gentleman, R. (2008). R programming for bioinformatics. CRC Press.
- R, Notes on R: A Programming Environment for Data Analysis and Graphics Version 2.10.1.
- Venables, W. N., & Smith, D. M. (2009). The R Development Core Team: An Introduction to

ADDITIONAL REFERENCES:

- R Programming, conducted by Johns Hopkins University. https://www.coursera.org/course /rprog
- Explore Statistics with R, conducted by Karolinska Institutet. https://www.edx.org/course/ kix/kix-kiexplorx-explore-statistics-r-1524#.VGsgSPmUf0k
- Carey, V. J., Huber, W., Irizarry, R. A., & Dudoit, S. (2005). Bioinformatics and computational biology solutions using R and Bioconductor (Vol. 746718470). R. Gentleman (Ed.). New York: Springer.
- Murrell, P. (2005). R graphics. CRC Press.
- http://www.r-project.org/
- http://manuals.bioinformatics.ucr.edu/home/R_BioCondManual

Semester : I
Course Code : BIN -E-415(iv) (Elective Skill Course)
Course Title : COMMUNICATION SKILL IN ENGLISH
Credits : 2

AIM: To become aware of one's own latent skills that are required for both life and profession in the modern age and develop them substantially.

COURSE OBJECTIVES:

- To enhance the communication skill by group discussions, role plays and activities
- To enhance the will power of the student and motivate them to achieve greater heights in life and profession.

COURSE CONTENT

Module I: Personal Skills: Knowing oneself – Confidence Building – Defining Strengths Thinking Creatively - Personal Values –Time and Stress Management -Language Practice -Review – Language Test.

Module II: Social Skills: Appropriate and Contextual Use of language - Interpersonal Skills – Understanding Media – Public Speaking – Language Practice-Review –Language Test

Module III: Organizational Skills: Planning – Team Work – Coordination –Language -Practice – Review – Language Test

REFERENCES:

- Burn, G. (2011). Motivation for dummies. John Wiley & Sons.
- Fox, A., & Fox, B. (2008). Positive Thoughts Positive Action. Jaico Publishing House.
- Klaus, P. (2009). The Hard Truth About Soft Skills: Soft Skills for Succeeding in a Hard Work. HarperCollins.
- Ramesh, G., Ramesh, M. (2011). The ACE of Soft Skills: Attitude, Communication and Etiquette for Success. Pearson Education India.
- Rao, S. (2010). Soft Skills: Enhancing Employability: Connecting Campus with Corporate. I.K. International Publishing House Pvt. Limited
- Reddi, B. (2012). Soft Skills and Life Skills: The Dynamics of Success. BSC Publishers and Distributors.
- Sherfield, R. M. (2009). Cornerstone: Developing Soft Skills. Pearson Education.
- Smith, J. (1997). How to be a better time manager. Kogan Page.

ADDITIONAL REFERENCES

- Enhance Your Career and Employability Skills conducted by University of London https://www.coursera.org/course/career
- Practical Management for Career Readiness conducted by University of California https://www.coursera.org/specialization/managementbasics/16?utm_medium=catalogSpec

Semester : II
Course Code : BIN -C-421
Course Title : CREATIVITY, RESEARCH & KNOWLEDGE MANAGEMENT
Credits : 4

AIM: This course will be a combination of lectures and directed activities aimed at developing an in-depth understanding of the scientific method and research process management. Activities in creativity and creative thinking, development of hypothesis, design of experiments, scientific research writing and critical reviewing will form the central part of the course.

COURSE OBJECTIVES:

- To trigger the creativity of students
- To temper research attitudes and skills
- To create awareness about current issues related to research management and ethics

COURSE CONTENT

Module I: Creativity & Thinking Skills: Various views on creativity; stimulating creativity; obstructions to creativity; creativity & innovation, creativity & craft; critical thinking; logical thinking – inductive & deductive logic – common logical fallacies; problem solving strategies.

Module II: Research and it types : Various outlooks on research: pure versus applied, incremental versus innovative, qualitative versus quantitative; Philosophy of science; the scientific method, the research process –creative question – hypothesis – planning and designing of experiments – critical analysis – sources of errors and minimization.

Module III: Research Report Writing: Format of a science research paper – the IMRAD format – objectives of each section – reference citing styles; Proof reading & editing; Publishing Science: Authorship; Publication process -Peer review – single/double blind and open; fabrication, falsification and plagiarism – Turnitin; Open Access Publications and other emerging trends in scientific communication; case study of paper writing and peer review; popular journals in Computational Biology & Bioinformatics (brief overview of their scope).

Module IV: Knowledge Management Skills: Active reading, listening and comprehension skills; Learning about Learning- multiple intelligences- learning styles; Advanced internet search skills – specialized academic search; Google scholar and Scopus; Bibliometrics and webometrics – impact factors –h, h-b and g indices – pitfalls in interpreting impact; Reference management tools: diigo, zotero, mind manager, endnote; Academic search engine optimisation; Current awareness: RSS feeds, TOC alerts, DB alerts.

Module V: IPR awareness: Copy lefts, copyrights and patents; IPR of software and life forms; Brief overview of IPR laws in India - Protection of traditional knowledge; Patent amendment of 2005 and its impact; Overview of International treatise – GATT, TRIPS; India as an emerging

Knowledge power; Ethics – its role in scientific research and academics, conflict of interests; academia-industry collaborations.

Module VI (**Flexi module-** *Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way)*: Allied Topics: Profile of key Bioinformatics/CB/ pharmaceutical institutions and industries in India& abroad. Overview of Bioinformatics policy of Govt. of India; Job opportunities in CB/BI & skill profiles; Quality – basic concepts – popular certifications; Making effective multi-media and poster presentations; Professional Societies in the field – their role in research and knowledge dissemination.

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- Oech, R.V. (1983).A Whack on the Side of the Head: How to Unlock Your Mind for Innovation. Warner Books.
- Osborn, A. F. (1953). Applied Imagination: Principles and Procedures of Creative Thinking. Charles Scribner's Sons, New York.
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- Weisberg, R. (1993). Creativity - Beyond the Myth of Genius. W.H. Freeman and Company.
- Creative problem solving, conducted by University of Minnesota. https://www. coursera. org/course/cps
- Creativity, innovation, and change, conducted by Pennsylvania State University. https:// www.coursera.org/course/cic
- Understanding research methods by University of London. https://www.coursera.org /course/researchmethods

Semester : II
Course Code : BIN -C-422
Course Title : FUNDAMENTALS OF MOLECULAR BIOLOGY
Credits : 4

AIM: To expose students to the fundamental concepts of modern molecular biology.

COURSE OBJECTIVES:

- To provide basic knowledge of the structural and functional properties of the cell
- To gives an introduction to Genetics, followed by the structure and composition of DNA and RNA.
- To introduce the basic techniques in Biotechnology like - rDNA technology, Polymerase chain reaction and Nucleic acid hybridisation
- To familiarize the basic concepts in Biophysics

COURSE CONTENT

Module I: Molecular basis of life –Genetic basis of Inheritance (Mendelian inheritance & extensions), Chromosomal basis of Inheritance, Experimental pro of DNA and RNA as genetic material, Watson& Crick model of DNA, Different forms of DNA& RNA.

Module II: Genes & their expression: Concept of gene, chemical & physical nature of gene, introns, exons, splicing, Junk DNA, Promoters, Enhancers, Silencers, Gene Expression & Regulation of gene expression in prokaryotes & eukaryotes, lac operon.

Module III: Gene Mapping: Transposons & Retroposons, Gene loci, genetic linkage map, physical map, QTL mapping. Mutations and their consequences, DNA Repair

Module IV: Biotechnology: Basic concepts, E.coli as a model organism. Genetic Engineering; recombinant DNA, Enzymes used in rDNA technology- Endo nuclease, Exonuclease, restriction endonucleases, Ligase, Reverse transcriptase, DNA Polymerase; Foreign DNA, Cloning vectors- plasmids, phages, cosmids, BACs, YACs; Steps involved in rDNA technology, PCR, primers, Applications of cloning and rDNA technology, cDNA, cDNA construction, cDNA library, Genomic library, EST.

Module V: Basic methods: Nucleic Acid Hybridization: Principle and application - Preparation of nucleic probes, Principle of Nucleic acid hybridization, Gene therapy, Antisense RNA & other Oligonucleotides. DNA finger printing- methodology and applications.

Module VI: Introduction to Biophysics: Structure of atoms, molecules & chemical bonds, Thermodynamics – entropy, enthalpy, free energy, chemical kinetics, Solutions – pH, electrolytes, acids, bases, buffer. Principles and applications of chromatography, gel filtration, Ultracentrifugation.

REFERENCES:

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- Watson, J. D., Gilman, M., Witkowski, J., & Zoller, M. Recombinant DNA.
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ADDITIONAL REFERENCES:

- Biology, conducted by University of Massachusetts, Boston. http://intro.bio.umb. edu/111-112/
- Genes and the human condition (from behavior to Biotechnology), conducted by University of Maryland. https://www.coursera.org/course/genes
- Introductionto thermodynamics. https://www.coursera.org/course/introthermodynamics
- The Molecular Biology notebook online- a beginners' guide to molecular biology www. rothamsted.ac.uk/notebook/
- The Virtual Library of Biochemistry, Molecular Biology and Cell Biology. Biochemweb.org/ general.shtml

Semester : II
Course Code : BIN -C-423
Course Title : COMPUTATIONAL GENOMICS
Credits : 4

AIM: To introduce basic genomic and transcriptomic sequence processing algorithms and concepts and impart skills regarding the use of popular software tools in this area.

COURSE OBJECTIVES:

- To familiarize the students with most basic and useful algorithms for sequence analysis
- To aware the students with basic file formats
- To transform the basic molecular data for interpreting their patterns for various analysis
- To compare genomes of different species, gene finding, and gene regulation

COURSE CONTENT

Module I: String view of DNA: Composition of DNA-(Chargaff's Rule), Reading frames +1, +2, +3 and -1, -2, -3, ORFs, Codon usage bias, tandem and inverted repeats, concepts of similarity - homologous, orthologous and paralogous sequences.

Module II: Basic file formats: FASTA, GenBank, EMBL, GCG, PIR, Phylip, Nexus file formats etc. Sequence Data Bases, detailed study of GenBank of NCBI- typical Gen Bank (DDBJ+EMBL) for DNA and RNA,

Module III: Sequence Representation & Analysis: Basic gene statistics–base counts, word(n-mer) frequencies, , vector contamination analysis, experiments using Perl scripts, gene finding, splice site recognition, transcription factor binding site identification, SNPs, microsatellite, minisatellite, sequence profiles, sequence logos, sequence chromatograms.

Module IV: Sequence alignment: Pair-wise sequence alignment, Need of Scoring schemes- Penalizing gaps – Linear and Affine gap penalty; Effect of scoring schemes, Scoring matrices for amino acid sequence alignment, PAM Probability matrix- Log odds matrix; BLOSUM; Dot-plot visualization; Smith –Waterman algorithm for local alignment, Needleman-Wunsch algorithm, Statistics of Sequence alignment score: E- values, bit scores and sensitivity, specificity; BLAST and FASTA.

Module V: Multiple sequence alignment: Need for MSA, SP measure- n dimensional dynamic programming- Heuristics algorithm for multiple sequence alignment - Progressive alignment, Iterative alignment - Tools for local, global and MSA: Muscle, T-Coffee, and ClustalW.

Module VI :(**Flexi module-** Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way): **Transcriptomics:** Concept of Transcriptome, transcriptome analysis and Gene Expression-An Overview-introduction to microarrays; Types of non-coding RNA's- lncRNAs, miRNAs, piRNAs, siRNAs ceRNAs etc., RNA databases,

RNA interference, RNA structure prediction tools, RNA sequence analysis, RNA regulatory networks; Transcriptome assembly, Comparative transcriptomics; short ORFs, encode project.

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- Xiong, J. (2006). Essential bioinformatics. Cambridge University Press
- Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. Garland Science.

ADDITIONAL REFERENCES:

- Bioinformatic methods I, conducted by University of Toronto. https:// www.Coursera.org/ course/bioinfomethods1
- Bioinformatics algorithms (Part 1), conducted by University of California San Diego. https://www.coursera.org/course/bioinformatics
- Bioinformatics: introduction and methods conducted by Peking University. https://www. coursera.org/course/pkubioinfo
- http://www.ncbi.nlm.nih.gov/education/tutorials/
- http://www.ncbi.nlm.nih.gov/books/NBK143764/

Semester : II
Course Code : BIN -C-424
Course Title : BIOINFORMATICS LAB II
Credits : 3

AIM: To provide hands on experiences covering course COB 202, COB 203 & COB 205 of semester II.

COURSE OBJECTIVES:

- To encourage students to understand the concepts learned in Molecular Biology and Genomics courses by direct experimentation.
- To introduce techniques like DNA extraction, amplification and quantification of Biomolecules
- To learn the analysis of various biological data using Perl script

COURSE CONTENT

Module: 1: Extraction of DNA, and Protein from various tissues, Quantification of DNA, Quantification of protein by Lowry's method.

Module: II: Molecular Biology Techniques: Chromatography: Paper, Thin layer, Electrophoresis: AGE, PAGE, SDS-PAGE, Amplification of DNA -Polymerase Chain Reaction.

Module: III: Insilico Experiments: Genomics- orf finder, Gene finder, Sequence alignment- pairwise –Blast, Dot plot analysis, multiple sequence alignment.

Module: IV:PERL: Data analysis using Perl programming language Validating DNA/ RNA/ Amino acid sequences, Finding complement & reverse complement of DNA sequence, Writing a sequence in fasta format, Computing the nucleotide composition of a given DNA sequence. Computing the amino acid composition of a given protein sequence.

Module: V: PERL: Finding the AT Composition of a given DNA sequence, Finding the GC Composition of a given DNA sequence, Finding the ORFs in a given DNA sequence, Transcribe a DNA sequence into RNA.

Module: VI: PERL: Translate the given DNA sequence into corresponding amino acid sequence-Mapping amino acid sequence with different physiochemical features like hydrophobicity, finding n-mer frequencies in DNA and amino acid sequences.

REFERENCES:

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- http://www.ncbi.nlm.nih.gov/books/NBK143764/
- http://www.ncbi.nlm.nih.gov/education/tutorials/

Semester : II
Course Code : BIN-E-425(i)
Course Title : PERL AND BIOPERL
Credits : 4
Co-requisite : BIN-C-424 BIOINFORMATICS LAB II

AIM: To impart moderate to advanced level skills in programming in Perl and Bioperl. Perl is a popular, general-purpose, multi-paradigm, open-source, scripting language.

COURSE OBJECTIVES:

- To introduce programming in Perl for students who have no prior programming experience
- To cover basic language syntax, string processing, and some advanced concepts including object oriented concepts, CGI scripting and database interaction
- The course is supplemented with many hands on labs using Linux
- To equip the student to write non trivial Perl programs dealing with a wide variety of life science domains

COURSE CONTENT

Module I: Perl Basics: Evolution & Environment – Features of Perl; Scalar Data & Operators, Control Structures. Lists & Arrays, Array Functions, Associate Arrays, Arrays & Data Containers, Hash.

Module II: Functions: User defined functions – Built in Functions, References, Regular Expressions – Processing Text with R.Es. Strings & Sorting Smart Matching, Perl Modules

Module III: File handling regular expression: File handling and regular expression, File I/O, Directory Operations; Perl & Relational Data bases, Basic operations in regular expression-Match operation, substitute operation, Translate operation

Module IV: Web programming and Perl: Introduction to web programing, Perl and web, CGI & HTML Forms-Perl scripting for CGI, Cookies & sessions

Module V: Principles of Object Orientation, Creating Classes, Instance Methods, Special Methods, Class Variables, Inheritance, Polymorphism, Type Identification, Exceptions- Errors, Run Time Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions, Writing new Exception Classes.

Module VI: (Flexi module- Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way.**)**: Perl & Graphics, Process Management, BioPerl– Basics, Overview of Bio Perl objects, seq objects, BLAST parsing, Annotated data base sequences.

REFERENCES:

- Schwartz, R. L., & Phoenix, T. (2001). Learning Perl. O'Reilly & Associates, Inc.
- Tisdall, J. (2003). Mastering Perl for bioinformatics. "O'Reilly Media, Inc."
- Zamora, M. C. (2013). Programming with Perl.

ADDITIONAL REFERENCES:

- http://www.bioperl.org/wiki/BioPerl_Tutorial
- http://www.ebi.ac.uk/~lehvasla/bioperl/BioperlOverview.html
- http://learn.perl.org/tutorials/
- https://www.perl.org/books/beginning-perl/

Semester : II
Course Code : BIN-E-425(ii)
Course Title : CASE STUDY
Credits : 2

AIM: To provide student with opportunity to experience independent problem solving of a non - trivial bioinformatics problem and to familiarize with the ongoing works in the field.

COURSE OBJECTIVES:

- To focus an independent problem solving exercise in Bioinformatics or allied areas, this involves 40 hours of intellectual activity including documentation
- Case study need not be an innovative work; it can be duplication of an already published work
- The topics for the case study shall be proposed by the students in consultation with supervisors
- Case studies may involve technical work or also professional tasks like preparation of funding proposals
- Case study can be done as a team work, but will be assessed based on individual effort and individual reports

Semester : **II**
Course Code : **BIN-E-425(iii)**
Course Title : **ANDROID APP DEVELOPMENT FOR BIOINFORMATICS**
Credits : **2**

AIM: To impart moderate programming skills in Android app development.

COURSE OBJECTIVES:

- To introduce basic Mobile Computing and Android app Development Environment
- The course is supplemented with some hands on labs using Linux
- The student will be able to write moderate Android applications dealing with a selected variety of life science domains

COURSE CONTENT

Module I: Introduction: Introduction to Mobile Computing and Android Development Environment, Mobile Software Engineering, Introduction to Android, Native Android Application, Android web application, Android SDK Features, Open Handset Alliance, Android Development Framework, Android Application Architecture.

Module II: Language Components: Intents and Services: Android Intents and Services, Characteristics of Mobile Applications, Successful Mobile Development. Storing and Retrieving Data: Synchronization and Replication of Mobile Data, Storing and Retrieving Data, Fundamental Android UI Design, Using Eclipse, Phone gap.

Module III: Communications via Network, Web and Database: Android Databases, Introducing SQLite, Using Location based Services, Emulator to test Location based Services, Wireless Connectivity and Mobile Apps, Android Telephony. Notifications and Alarms: Performance and Memory Management, Android Notifications and Alarms.

Module IV: Graphics and Multimedia: Performance and Multithreading, Graphics and UI Performance, Android Graphics, Mobile Agents and Peer-to-Peer Architecture, Android Multimedia.

REFERENCES:

- B'Far, R. (2005). Mobile computing principles. México: United Kingdom. Ed. Cambridge University Press. ISBN, 881284340.
- Darcey, L., & Conder, S. (2012). Android Wireless Application Development Volume I: Android Essentials. Addison-Wesley.
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- Renault, D. N. E., & Dhanuskodi, M. (2011). Advances in Parallel, Distributed Computing.

- Steele, J., & To, N. (2010). The Android developer's cookbook: building applications with the Android SDK. Pearson Education.

ADDITIONAL REFERENCES:

- Android Capstone Project, conducted by Vanderbilt University and University of Maryland. https://www.coursera.org/umd
- Creative, Serious and Playful Science of Android Apps, conducted by University of Illinois at Urbana-Champaign. https://www.coursera.org/course/androidapps101.
- http://www.coreservlets.com/android-tutorial/
- http://www.lynda.com/Android-training-tutorials/947-0.html
- http://www.tutorialspoint.com/android/
- http://www.vogella.com/tutorials/android.html
- https://developer.android.com/training/index.html

Semester : II
Course Code : BIN -E-425(iv)
Course Title : NEGOTIATED STUDIES
Credits : 2

AIM: This course is aimed at ensuring flexibility and dynamism of the syllabi. The course content will be negotiated by the students with the faculty and finalized and thereafter offered as a regular course.

COURSE OBJECTIVES:

- The students in Department of Computational Biology and Bioinformatics of any semester may make a proposal for a 2-credit course in an emerging and cutting edge area for consideration as a regular course.
- The proposal may contain a statement of need for the course, proposed course content and references or resources identified.
- Such proposal shall be made at least one month before the commencement of the semester in which the course is proposed to be on offer.
- The Department council shall hold a meeting in which students shall be invited and the decision on offering the course shall be discussed and debated.
- The Department will take into its consideration the intellectual and infrastructural requirements, rationale and the demand of the students and decide on whether to offer the course or not.
- The decision of the Department Council shall be final. In the course transcript, the course shall be indicated as "Negotiated Studies (Title approved by Department Council)".

Semester : II
Course Code : BIN-E-425(v) (Elective Skill Course)
Course Title : COMMUNICATION SKILL IN ENGLISH
Credits : 2

AIM: To become aware of one's own latent skills that are required for both life and profession in the modern age and develop them substantially.

COURSE OBJECTIVES:

- To enhance the communication skill by group discussions, role plays and activities
- To enhance the will power of the student and motivate them to achieve greater heights in life and profession

Module I: Professional Skill: Job Oriented Skills - Professional Etiquette – Business - Communication – Language Practice –Review – Language Test.

Module II: Preparing and Presenting a Project: Agreeing on a Theme and Setting up a Timeline – Brainstorming and Doing Effective Interest Searches –Gathering Information – Compiling and Analyzing Information – Revising and Editing -Preparing and Designing a Power Point Presentation – Delivering Presentations and Review.

REFERENCES:

- Burn, G. (2011). Motivation for dummies. John Wiley & Sons.
- Fox, A., & Fox, B. (2008). Positive Thoughts Positive Action. Jaico Publishing House.
- Klaus, P. (2009). The Hard Truth about Soft Skills: Soft Skills for Succeeding in a Hard Work. HarperCollins.
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- Smith, J. (1997). How to be a better time manager. Kogan Page.

ADDITIONAL REFERENCES:

- Enhance Your Career and Employability Skills conducted by University of London https://www.coursera.org/course/career.
- Practical Management for Career Readiness conducted by University of California https://www.coursera.org/specialization/managementbasics/16?utm_medium=catalogSpec

Semester : III
Course Code : BIN-C-431
Course Title : PROTEOMICS AND CADD
Credits : 4

AIM: The course will be familiarised with basics of protein, its structure various proteomics databases, sequences analysis and structure visualization software.. A step by step outline of Drug Discovery Pipeline-from Target identification to Clinical trials- with emphasis on various computational drug discovery approaches is planned. The students will be also given practical training in structure analysis, modelling, molecular docking, ADME predictions etc.

COURSE OBJECTIVES:

- To develop basic understanding about computational techniques in proteomics
- To inculcate skills in protein sequence analysis and structure modelling
- To impart knowledge on molecular mechanism of diseases and drug action
- To provide training in molecular docking and ADME predictions
- To develop appreciation about computational drug design techniques

COURSE CONTENT

Module I: Preliminaries: Proteome and proteomics –Proteins as workhorse molecules of life, classification of proteins, Protein separation & analysis; 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry. Protein structure determination with X-ray Crystallography & NMR spectroscopy.

Module II: Protein Structure: Interatomic forces and protein structure; covalent interaction, hydrogen bonds, hydrophobic and hydrophilic interaction, charge/dipole interaction, Vander Waals forces, steric interaction. Primary structure; 20 amino acids as structural units, peptide bonds, proteins as polypeptides. Secondary structure; Alpha helices, Beta sheets and turns, Ramachandran plot Backbone flexibility- Φ and ψ- Properties of amino acids-Hydrophobicity, EIIP, Molecular weight, α and β propensities. Tertiary and quaternary structures, protein folding, protein domains.

Module III: Protein databases: UniProtKB/Swiss-Prot, Interpro, PIR, PDB, SCOP & CATH, ProDom, PFAM; Protein visualization tools- Swiss PDB Viewer, Pymol. Expasy proteomic tools: AA CompIdent, MultiDent, Peptide Mass etc. Introduction to software: JPred, 3DPSSM, Modeller, ITASSER, Procheck;

Module IV: Protein structure prediction: Chou Fasman method- p(a), p(b) and p(turn) propensities, Garnier Osguthorpe and Robson(GOR) method, Threading, Homology modeling, CASP, Abinitio prediction, Molecular dynamics & conformational energy calculation, Prediction of function.

Module V: Drug Discovery: Review of basic biological concepts- Diseases and their causes-molecular basis of diseases. Immunology- cells and molecules in immune system, antigens & antibodies, immune response, vaccines. Molecular targets, Characteristics of a drug compound, mechanism of drug action, small molecular drugs, peptide drugs. Traditional approaches in drug discov-

ery, serendipity, high throughput screening, and drug discovery in post-genomic era. Drug discovery pipeline, pre-clinical & clinical studies, IP issues in Drug Design, drug licensing in India.

Module VI: (Flexi module- Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way**): Computational approaches in Drug Design:** Applications of bioinformatics in target identification & validation, binding site prediction. Lead compound identification: Structure-based & ligand based approaches; Molecular docking- algorithms and scoring functions; Virtual screening- combinatorial chemistry and ligand databases; Design of ligands for known target sites- de novo techniques. Lead optimization. Pharmacophore -ligand based & target based. QSAR - molecular descriptors, bio-activity predictions. ADME Predictions. Introduction to Software: Autodock, Gold etc**.**

REFERENCES:

- Bergeron, B. P. (2003). Bioinformatics computing. Prentice Hall Professional.
- Charifson, P. S. (1997). Practical application of computer-aided drug design. Marcel Dekker, Inc.
- Claverie, J. M., & Notredame, C. (2011). Bioinformatics for dummies. John Wiley & Sons.
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- Pevsner, J. (2009). Bioinformatics and functional genomics. John Wiley & Sons
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- Setubal, J. C., Meidanis, J., & Setubal-Meidanis. (1997). Introduction to computational molecular biology. PWS Pub.

- Silverman, R. B., & Holladay, M. W. (2014). The organic chemistry of drug design and drug action. Academic press.

ADDITIONAL REFERENCES:

- Drug Discovery, Development & Commercialization, conducted by University of California San Diego. https://www.coursera.org/course/drugdiscovery
- Medicinal Chemistry: The Molecular Basis of Drug Discovery, conducted by Davidson College. https://www.edx.org/course/davidsonx/davidsonx-d001x-medicinal-chemistry 271 1#.VDzx1vmSz0k

Semester : III
Course Code : BIN-C-432
Course Title : PHYLOGENETICS
Credits : 4

AIM: To expose students to basic concepts & algorithms in computational phylogenetics based on molecular data and to impart skills in use of popular computing tools in this area.

COURSE OBJECTIVES:

- To introduce basic molecular phylogenetics with emphasis on the different methods and algorithms
- To familiarize different software to construct phylogenetic tree
- To provide an outline for tree analysis and interpretation

COURSE CONTENT

Module I: Background Knowledge: Evolutionary Biology – From atoms to molecules to life, Hypothesis of evolution, Darwin's theory of evolution, From taxonomy to molecular phylogenetics – Linnaeus' classification systems- Whittaker's five kingdom system, Carl Woese's three domain system; Traditional Systematics/phylogeny.

Module II: Tree concept: Molecular data as molecular fossils; Molecular-clock-hypothesis; The terminology of phylogenetics- Trees, Root, branches, Node, Leaf, Clade; lineage sorting, orthology, paralogy, xenology; "basal" lineages, crown vs. stem groups, Phylogram vs. cladogram.

Module III: Molecular phylogeny : Gene phylogeny vs. species phylogeny; Different types of trees- rooted vs. unrooted trees, dichotomy vs. polytomy, monophyletic vs. paraphyletic, ultrametric vs. unconstrained; Constructing molecular phylogenetic trees-Choice of molecular markers.

Module IV: Phylogenetic Algorithms: Clustering based methods-UPGMA and neighbor joining, Optimality based: Fitch-Margoliash and minimum evolution algorithm; Character based methods-Maximum Parsimony (MP) and Maximum Likelihood (ML) methods; Bayesian inference, Evaluation of phylogenetic trees-reliability and significance; Boot strapping; Jackknifing.

Module V: Phylogenetic software & applications: Multiple sequence alignment & Tree building software - ClustalW, Mega, Phylip, Phylodraw, Phyml, RaxML; Case studies- Phylip/Mega.

Module VI: (Flexi module- Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way**) Allied topics**: Population genetics. Genetic polymorphism, variations, alleles, Human Y-chromosome haplogroups, Mitochondriomics: - Mitochondrial haplogroups, rCRS, SNP, Mitochondrial eve, Human mitochondrial molecular clock, prevalence in mitochondrial haplogroups, Human Genographic project, mitochondrial polymorphism, Dysfunction and disease studies.

REFERENCES:

- Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). Bioinformatics: Methods And Applications: (Genomics, Proteomics and Drug Discovery). PHI Learning Pvt. Ltd.
- Xiong, J. (2006). Essential bioinformatics. Cambridge University Press.
- Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. Garland Science.

ADDITIONAL REFERENCES:

- Computational Molecular Evolution, conducted by Technical University of Denmark. https://www.coursera.org/course/molevol.
- Experimental Genome Science, conducted by University of Pennsylvania. https://www.cour sera.org/course/genomescience

Semester : III
Course Code : BIN-C-433
Course Title : ADVANCED TOPICS IN COMPUTATIONAL BIOLOGY
Credits : 4

AIM: To expose the students to emerging areas in the field of new biology from a computational perspective.

COURSE OBJECTIVES:

- To provide basic introduction to Systems Biology, properties of biological systems and approaches in systems biology to analyze and interpret data
- To give an overview of Synthetic Biology and analytical computational methods discussed with the help of tools and software
- To understand the recent trends in genomics like toxicogenomics, pharmacogenomics, NGS etc.
- To familiarize the advanced topics in CADD like pharmacodynamics & pharmacokinetics
- To introduce metabolomics with its profiling and analysis

COURSE CONTENT

Module I: Systems biology: Self-organization, emergence, modularity and abstraction, feedback, control analysis, Enzyme Kinetics and Thermodynamics: The Law of Mass Action; Reaction Kinetics, Rate Equation, Michaelis-Menten Equation, Hill Equation, Interaction networks overview- Gene Regulatory Network, Protein – Protein Interaction Network, Signaling Pathways, Metabolic pathways; network motifs, Systems Biology tools and standards: Matlab -Systems Biology toolbox; SBML; SBGL (Systems Biology Graphical Language); KEGG; Tools for systems Biology- Cell designer; Cytoscape.

Module II: Synthetic Biology: Engineering Biology; design and construction of novel biological systems; Abstraction hierarchy-Part, Device, Systems; BioBricks - a standard for (physical) DNA composition, Designing a biological system from Biobricks; iGEM; SBOL, Computational Synthetic biology: Codon optimization; AND gate and OR gate in biology; Operons; Switches and clocks; Repressilator; Applications- Environment, Energy, Pharmaceutical needs, Ethical issues of Synthetic Biology.

Module III: Niche areas in Genomics: Toxicogenomics, Pharmacogenomics-Pharmacogenetics, SNP, Personalized medicine, Metagenomics, Comparative genomics, Functional genomics, structural genomics, QTL, HGP.

Module IV: Next Generation Sequencing methods, Overview of data compression, Need for compression, Scope of NGS data compression.

Module V: Advanced topics in CADD: Molecular dynamics simulations, Force fields, Energy minimization, pharmacodynamics & pharmacokinetics, 2D and 3D screening, Identification of targets in silico, GPCRs, Peptides as drugs, introduction to Ayurinformatics.

Module VI: (Flexi module- Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way**):** Metabolomics: Metabolism, metabolomite, metabolome, metabolomic separation and analysis techniques, metabolic profiling, metabolic fingerprinting, Metabolome informatics. Resources/databases of metabolomics, Applications; Epigenetics.

REFERENCES:

- Alon, U. (2006). An introduction to systems biology: design principles of biological circuits. CRC press.
- Benson, G. (2003). Algorithms in Bioinformatics. Springer Berlin Heidelberg.
- Boogerd, F., Bruggeman, F. J., Hofmeyr, J. H. S., & Westerhoff, H. V. (Eds.). (2007). Systems biology: philosophical foundations. Elsevier.
- Choi, S. (Ed.). (2007). Introduction to systems biology. New Jersey:: Humana Press.
- Demin, O., & Goryanin, I. (2010). Kinetic modelling in systems biology. CRC Press.
- Gautham, N. (2006). Bioinformatics: Databases and Algorithms. Alpha Science Int'l Ltd.
- Gusfield, D. (1997). Algorithms on strings, trees and sequences: computer science and computational biology. Cambridge University Press.
- Iyengar, S. (2010). Symbolic Systems Biology. Jones and Bartlett.
- Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., Lehrach, H., & Herwig, R. (2013). Systems biology. John Wiley & Sons.
- Krawetz, S. A. (2009). Bioinformatics for systems biology. Springer.
- Leister, D., & Herrmann,J. (Eds.). (2007). Mitochondria: practical protocols (Vol. 372). Springer
- Mallick, B. (2008). Bioinformatics: principles and applications. Oxford University Press.
- N. Claude Cohen (Ed.). (1996). Guidebook on molecular modeling in drug design. Gulf Professional Publishing.
- Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). Bioinformatics: Methods And Applications-(Genomics, Proteomics and Drug Discovery). PHI Learning Pvt. Ltd.
- Smith, H. J., & Williams, H. (2005). Smith and Williams' introduction to the principles of drug design and action. CRC Press.
- Voigt, C. (2011). Synthetic Biology, Part B: Computer Aided Design and DNA Assembly. Methods in enzymology. Elsevier Science
- Voigt, C. (Ed.). (2011). Synthetic Biology: Methods for part/device characterization and chassis engineering. Academic Press.

ADDITIONAL REFERENCES

- Dynamical Modeling Methods for Systems Biology, conducted by Icahn School of Medicine. https://www.coursera.org/course/dynamicalmodeling
- Experimental Methods in Systems Biology, conducted by Icahn School of Medicine.
- https://www.coursera.org/course/expmethods
- https://www.coursera.org/course/integratedanalysis
- https://www.coursera.org/specialization/systemsbiology/6?utm_medium=catalogSpec
- Integrated Analysis in Systems Biology, conducted by Icahn School of Medicine
- Introduction to Systems Biology, conducted by Icahn School of Medicine.
- Network Analysis in Systems Biology, conducted by Icahn School of Medicine. https://www.coursera.org/course/netsysbio
- http://openwetware.org/wiki/IGEM

Semester : III
Course Code : BIN-C-434
Course Title : BIOINFORMATICS LAB III
Credits : 3

AIM: To provide hands on experiences in Proteomics software tools, CADD tools and soft computing platform.

COURSE OBJECTIVES:

- To make students acquainted with indispensable tools in proteomics and CADD
- To understand the basic tools for phylogenetic analysis and their interpretation
- To familiarize pattern classification techniques

COURSE CONTENT

Module I: Structural proteomics: Sequence retrieval from Databases, Sequence analysis using different tools, Protein building tools, Structure prediction tools.

Module II: Structure Visualisation tool: Familiarization of various visualization tools like Pymol, Rasmol, Argus Lab, Swiss PDB viewer.

Module III: Phylogenetic Analysis: Sequence comparison by pairwise and multiple sequence alignment- Clustal Omega, Phylogenetic tree construction by various software.

Module IV: Soft Computing: Sequence pattern classification including non-trivial data base, feature extraction, processing, training & prediction including one of the following soft computing tools: ANN, SVM, HMM, RDQ, PCA, LDA.

Module V: NGS Data Analysis: Sequence analysis from various NGS platforms

Module VI: Metabolomics: Introduction to metabolites and metabolome, different techniques used to extract metabolites and analyze samples to collect metabolomic data: HPLC, or GC-based MS and NMR, Metabolic databases, Metabolic pathways resources and data analysis tools: KEGG, Cytoscape, MetNet etc.

REFERENCES:

- http://www.embl.de/proteomics/proteomics_services/links_tutorials/bookshelf/
- http://www.journals.elsevier.com/journal-of-proteomics/news/international-proteomics-tutorial-programme/
- http://evolution.berkeley.edu/evolibrary/article/0_0_0/phylogenetics_01

Semester : III
Course Code : BIN-E-435(i)
Course Title : DSP AND SOFT COMPUTING
Credits : 4

AIM: The students are introduced to the concepts about soft computing and different techniques in soft computing, fuzzy logic and fundamentals of DSP.

COURSE OBJECTIVES:

- To introduce fundamental concepts of DSP
- To introduce soft computing and dimensionality reduction techniques
- To expose students to application of DSP and soft computing in Bioinformatics
- To familiarise software like Libsvm and WEKA

COURSE CONTENT

Module I: Introduction to Soft Computing: History - Comparison of hard computing and soft computing, Biological motivation in soft computing – comparison of human brain and CPU. Overview of different soft computing techniques: Fuzzy logic, fuzzy set, membership function, Fuzzy systems.

Module II: Artificial Neural Networks: Historic evolution – Perceptron, Features of NNs – Fault Tolerance, Parallelism, Flexibility and Additivity, Learning, Disadvantages; supervised and unsupervised networks, Multi – layer Perceptrons, Back Propagation Algorithm (Derivation not required), Hidden Markov Models. Overview of Evolutionary computing: Genetic Algorithm, Swarm intelligence, Ant Colony Optimization, Particle Swarm Optimization.

Module III: Signal Concepts: Signals: Types of Signals – Discrete, continuous, digital, periodic, symmetric. Examples of signals; Standard Signals: Impulse, Step, Ramp, Sinusoid, Noise etc. Basic operations on Signals Correlation, Impulse response theorem, convolution.

Module IV: Signal Analysis: Time domain and frequency domain – spectral analysis – Fourier theorem – Spectrograms, Bio spectrogram, DSP and Bio-sequences: Mapping bio-sequences to digital signals – various approaches –indicator sequences – distance signals – use of clustering to reduce symbols in amino-acid sequences.

Module V: Dimensionality Reduction techniques: Overview of Dimensionality Reduction techniques, K-means clustering, Principal Component Analysis -Eigen values & Eigen vectors of covariance matrix, choosing components. Overview of support vector machines.

Module VI: (Flexi module- Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way**)**: Use of chaos game representation to generate signals-analysis of bio sequence signals, case study of spectral analysis for exon

location and RRM for macromolecular interaction analysis. Soft computing tools: WEKA and applications to pattern classification and clustering function optimization and regression problems.

REFERENCES:

- Anastassiou, D. (2000). Frequency-domain analysis of biomolecular sequences. Bioinformatics, 16(12), 1073-1081.
- Anastassiou, D. (2000). Digital signal processing of biomolecular sequences. Technical Report, Columbia University, 2000-20-041.
- Cartwright, H. (2008). Using artificial intelligence in chemistry and biology: A practical guide. CRC Press.
- Cha, P. D., & Molinder, J. I. (2006). Fundamentals of Signals and Systems: A Building Block Approach. Cambridge University Press
- De Castro, L. N. (2006). Fundamentals of natural computing: basic concepts, algorithms, and applications. CRC Press.
- Dorigo, M., Birattari, M., & Stutzle, T. (2006). Ant colony optimization. Computational Intelligence Magazine, IEEE, 1(4), 28-39.
- Freeman, J. A., & Skapura, D. M. Neural networks: algorithms, applications, and programing techniques, 1991. Reading, Massachussets: Addison-Wesley.
- Ganesh, M. (2006). Introduction to fuzzy sets and fuzzy logic. PHI Learning Pvt. Ltd.
- Goldberg, D. E. (2006). Genetic algorithms. Pearson Education India.
- Gollery, M. (2008). Handbook of hidden Markov models in bioinformatics. Chapman & Hall/CRC.
- Gollery, M. (2008). Handbook of hidden Markov models in bioinformatics. Chapman & Hall/CRC.
- Koski, T. (2001). Hidden Markov models for bioinformatics (Vol. 2). Springer.
- Lyons, R. G. (2010). Understanding digital signal processing. Pearson Education.
- Mitra, S., & Hayashi, Y. (2006). Bioinformatics with soft computing. Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on, 36(5), 616-635
- Pratihar, D. K. (2007). Soft computing. Alpha Science International, Ltd.
- Sivanandam, S. N., & Deepa, S. N. (2007). Principles of soft computing .John Wiley & Sons.
- Smith, S. W. (2003). Digital signal processing: a practical guide for engineers and scientists. N ewnes
- Stein, J. Y. (2000). Digital signal processing: a computer science perspective. John Wiley & Sons, Inc..
- Sundararajan, D. (2003). Digital signal processing: theory and practice. World Scientific.
- Sung, W. K. (2011). Algorithms in bioinformatics: A practical introduction. CRC Press.
- Tiwari, S., Ramachandran, S., Bhattacharya, A., Bhattacharya, S., & Ramaswamy, R. (1997). Prediction of probable genes by Fourier analysis of genomic sequences. Bioinformatics, 13(3), 263-270.

ADDITIONAL REFERENCES

- Artificial Intelligence, conducted by the University of California, Berkeley. https://www. edx.org/course/uc-berkeleyx/uc-berkeleyx-cs188-1x-artificial-579
- Digital Signal Processing, conducted by École Polytechnique Fédérale de Lausanne. https: //www.coursera.org/course/dsp

Semester : III
Course Code : BIN-E-435(ii)
Course Title : Mini Project
Credits : 2

AIM: To prepare the students for the major project.

COURSE OBJECTIVES:

- Mini Project is envisaged as a preparation for the main project
- The key guide lines for the same is chosen by the supervising teachers shall be applicable
- Students, if they wish, may also dovetail Mini Project into Main Project

Semester : III
Course Code : BIN-E-435(iii)
Course Title : Big Data Bioinformatics
Credits : 3

AIM: This course presents a holistic approach to Big Data, its challenges and emphasizes the need to gain insight for better understanding of biological data.

COURSE OBJECTIVES:

- To foster interest in handling big data analysis and hands on experience for interpreting Next Gen sequence data
- To focus on various Next gen sequence data analysis tool kits
- To equip the students to analyze, visualize and interpret the big data

COURSE CONTENT

Module I: Introduction to Big data, Data science, X-informatics, Sources of Big data, Uses of Big data, Big data Holistic Approach- platform, Current challenges, trends, and applications, Computational facilities for analyzing Big data- Cluster Computing, Map Reduce, Hadoop & Cloud Computing.

Module II: DNA Data Deluge, Big data Challenges in Bioinformatics, Next generation DNA sequencing Informatics, Introduction to NGS technology, advantages, limitations and applications, Data sources: SRA, EBI-ENA, Format conversion, SRA toolkit, VCF Genome Browsers, NGS Data analysis -Methods, Data formats, Data handling, Quality, Trimming.

Module III: Alignment analysis - ChIP-seq, MeDIP, Metagenome and specialized application, Quality aware aligners- Principles and tools-BWA, Bowtie, Pipelines for reference assembly and variant calling, Concepts and Pipelines for RNAseq analysis-PolyA vs Total RNA, Concepts and analysis, ChiP-seq analysis: Peaks and peak calling, distribution, mapping and analysis.

Module IV: Advanced data analysis-Denovo assemblies, Genome/Exome Variant calling, Introduction to BAM, SAM & CRAM tools, RNA-seq analysis, ChIP-seq analysis, SOP denovo, Velvet, Model based Analysis for ChIP-seq (MACS).

Module V: (Flexi module- Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way**)**: Comparative genomics using NGS, application and pipeline development, for specific NGS application, NGS in Clinical diagnosis, Analysis of genome, Exome, Transcriptome; Visualization of Data in R; Interpretation of Data; Development of clinically relevant applications; Development of socially relevant applications.

REFERENCES:

- Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman(2013), Big Data for Dummies, Wiley
- Stuart M. Brown (2013), Next-Generation DNA Sequencing Informatics, Cold Spring Harbor Laboratory
- Yukiya Aoyama, Jun Nakano (1999)RS/6000 SP: Practical MPI Programming IBM Redbooks

ADDITIONAL REFERENCES:

- http://spectrum.ieee.org/biomedical/devices/the-dna-data-deluge
- http://159.226.149.45/kizsjzx/hpc/mpi-course.pdf
- Bowtie: http:// http://bowtie-bio.sourceforge.net/index.shtml
- Sam Tools: http:// http://samtools.sourceforge.net/
- BED Tools: https://code.google.com/p/bedtools/
- UCSC Tools: http://hgdownload.cse.ucsc.edu/admin/exe/
- IGV genome browser: http://www.broadinstitute.org/igv/
- MACS: http://http://liulab.dfci.harvard.edu/MACS/index.html
- PeakAnalyzer: http://www.ebi.ac.uk/research/bertone/software#peakanalyzer
- HTSeq-count: http://http://www huber.embl.de/users/anders/HTSeq/doc/count.html
- DESeq: http://bioconductor.org/packages/release/bioc/html/DESeq.html
- DEXSeq: http://http://bioconductor.org/packages/release/bioc/html/DEXSeq.html
- http://www.enterprisetech.com/2014/04/11/genome-researchers-battling-data-storage-bottlenecks/
- http://cufflinks.cbcb.umd.edu/
- http://www.ensembl.org/
- https://bigdatacourse.appspot.com/course
- https://bigdatauniversity.com/courses
- https://www.encodeproject.org/

Semester : IV
Course Code : BIN-E-441(i)
Course Title : SEMINAR II
Credits : 2

AIM: To give an opportunity for students to practice technical communication.

COURSE OBJECTIVES:

- To give an opportunity for self-study of a selected topic
- To practice serious focused reading and assimilation of science and technology literature
- To enhance the skill for scientific writing of a Research topic in research paper format in Bi-oinformatics (OUP) style
- To equip the students with formal presentation

Semester : IV
Course Code : BIN-E-441(ii)
Course Title : RESEARCH PROPOSAL PREPARATION
Credits : 2
Pre-requisite : BIN-C-421 CREATIVITY, RESEARCH & KNOWLEDGE MANAGEMENT

AIM: To give students opportunity to conceive and prepare a research proposal.

COURSE OBJECTIVES:

- To enhance the writing skills of students for hypothetical Research proposal preparation
- To enrich the awareness about the requirements for getting Research funds from national or international funding agency
- To equip the scholars with professional career in research and development

REFERENCES:

- Creswell, J. W. (2013). Research design: A qualitative, quantitative, and mixed method approaches. Sage.
- Mutai, B. K. (2000). How to write quality research proposal: A complete and simplified recipe. Kenya, Nairobi. Egerton University.
- Vakkari, P., Pennanen, M., & Serola, S. (2003). Changes of search terms and tactics while writing a research proposal: A longitudinal case study. Information processing & management, 39(3), 445-463.
- Vithal, R., & Jansen, J. (2012). Designing your first research proposal: a manual for researchers in education and the social sciences. Juta and Company Ltd.

Semester : IV
Course Code : BIN-D-442
Course Title : PROJECT AND VIVA VOCE
Credits : 15

AIM: To impart hands on experience in developing a solution to a real life bioinformatics problems in a professional manner.

COURSE OBJECTIVES:

- The students are required to carry out a four month individual project and submit a dissertation embodying the findings of the same
- The project work is to be done preferably in an external organization of repute such as national R and D institutions or global IT companies
- The student shall be permitted to work in the Department for project only in exceptional cases
- External Evaluation of the dissertation and conduct of viva-voce shall be done by a board of examiners appointed by the University
- The Viva shall, in addition to evaluation of project work, also attempt to gauge overall professional development of the student and also the generic subject awareness and knowledge of the student, mainly through an oral examination

Important Guidelines for Project

- Project should be selected at least 6 months prior to commencement. Planning Docket (Appendix A) should be used for this.
- Students are expected to spend a minimum of clear 8 hours per day, ideally 10-12 hours. This is sure to reflect on the quality and quantity of work.
- Students are encouraged to do project in an external organization, to expose them to professional R&D work culture.
- Students have to submit 3 Project Progress Reporting dockets (Appendix B) along with Work Reports (about 5 pages) as indicated in the weekly planner (Appendix C).
- Students should maintain Lab Note Books; with one page brief report for each day. Lab note books shall form a component for evaluation and shall be presented to the external examiner.
- Thesis writing should be done in a distributed manner and not in haste after finishing work. Collection of reference materials used should be produced during viva / discussion with supervisors, if required.
- Follow Week based Planner (Appendix C).
- For Student Peer Review, Interim Review, Self-Evaluation Report, Final External Evaluation reports should use form in Appendix D, E, F, G (i) & G(ii) respectively.
- Project Report should conform to Green Charter of the University of Kerala
- A summary of the project prepared in research paper format (3-4 pages) should be submitted along with project report

REFERENCES:

- Data Science, conducted by Johns Hopkins University. https://www.coursera.org/specialization /jhudatascience/1?utm_medium=courseDescripTop
- Understanding Research Methods, conducted by Johns Hopkins University. https://www.cour sera.org/course/research methods
- Design Research: Need finding & Feedback, conducted by Johns Hopkins University. https://w ww.coursera.org/course/design research
- Qualitative Research Methods, conducted by Johns Hopkins University. https://www.coursera. org/course/qualitative methods

Semester **: I, II, III**

Course Code **: BIN-X-411, BIN-X-421, BIN-X-431**

Course Title **: Introductory Bioinformatics**

Credits **: 2**

AIM: To expose students to the fundamental concepts of modern molecular biology.

COURSE OBJECTIVES:

- The course aims at the masters students who have basic knowledge in biology and computer science to gather basic and top view of Bioinformatics.
- The course also aims to enable students to use the basic tools and software to analyse and interpret the biological sequence data and information

COURSE CONTENT

Module I : Nature and scope of life sciences: Various branches of life sciences, organization of life at various levels, Overview of molecular biology, the cell as basic unit of life-Prokaryotic cell and Eukaryotic cell - Central Dogma: DNA-RNA-Protein, Introduction to DNA and Protein sequencing, Human Genome Project, SNP.

Module II: Bioinformatics databases: Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases; Protein databases- UniProt, Protein Data Bank.

Module III: Sequence Alignment: Basic concepts of sequence similarity, identity and homology, Scoring matrices- PAM and BLOSUM matrices, Pairwise sequence alignments: BLAST, Multiple sequence alignments (MSA)- CLUSTALW, Phylogeny: Basic concepts of phylogeny; molecular evolution; Brief introduction to Phylogenetics and phylogenetic tree construction.

Module IV: Protein Structure: Building Blocks- Amino Acids, Properties of amino acids – Properties of Amino acids- Hydrophobicity, Hydrophobicity, Acidic, Basic, Aromatic and Aliphatic, Levels of protein structure- Primary Secondary and Tertiary and quaternary structures, protein folding, Drug discovery pipeline.

REFERENCES:

- C. A. Orengo, D.T. Jones and J. M. Thornton, Bioinformatics- Genes, Proteins and Computers, Taylor & Francis Publishers
- Charles Semple, Richard A. Caplan and Mike Steel, Phylogenetics, Oxford University Press
- Claverie & Notredame, Bioinformatics - A Beginners Guide, Wiley-Dreamtech India Pvt
- Marketa Zvelebil and Jeremy O. Baum, Understanding Bioinformatics, Garland Science
- Michael Agostino, Practical Bioinformatics, Garland Science

ADDITIONAL REFERENCES:

- Resources at web sites of NCBI, EBI, PDB etc., Web tools for Bioinformatics

DEPARTMENT OF COMPUTATIONAL BIOLOGY & BIOINFORMATICS
UNIVERSITY OF KERALA
M. Sc. PROJECT DOCKET
PART-A: PROJECT PLANNING DOCKET
(To be filled in prior to project selection)

Name of the Student	
1. What broad area would you like to work? (put a tick mark)	1. Programming based ☐ 2. Including theory/ Mathematics ☐ 3. Bioinformatics including Wetlab ☐ 4.
2. List five areas of your Interest add (a mind map for each the topic as appendix)	1. 2. 3. 4. 5.
4. What are the general objectives of a Project work?	
5. List 5 skill sets you have in relation to your project work? 1. 2. 3. 4. 5.	
6. List three Institution and guides in consideration (If more than one person in an institution add additional sheets)	

Full address										
			PIN							
Email										
Phone										
Web										

Name of Guide	
His/Her current area of work	
Summary of their work that interests you(attach as appendix if lengthy)	
Skill sets required	
Constraints*	

Full address										
			PIN							
Email										
Phone										
Web										

Name of Guide	
His/Her current area of work	
Summary of their work that interests you(attach as appendix if lengthy)	
Skill sets required	
Constraints*	

Full address										
			PIN							
Email										
Phone										
Web										

Name of Guide	
His/Her current area of work	
Summary of their work that interests you(attach as appendix if lengthy)	
Skill sets required	
Constraints*	

Does the institution have date/ skill/ fee or other constraints? Briefly note

7. In case of institutions other than DCB, please mention logistics

a. Arrangements for stay	

b. Living Expenditure and/or Fees (affordable?)		
c. Support from family		
d. Mention 3 Key advantages of doing project in the concerned institution and three challenges that you envisage		
8. Do you plan for a publication? Mention your dream in this regard(title of the paper, one target journal)		
9. How many hours of work /day are you prepared to put in during the project? How will you raise so many hours? What changes will you make in your current routine		
10. Have you read the guidelines for writing project proposals? What are the key observations that you made?		
11. Have you read any past M. Phil / MSc. thesis ? Give a brief summary of it and add 3 critical observations		
12. List key resource persons you would like to consult regarding your project		
13. Your choice of (i)Internal supervisor and (ii)Assistant supervisor (ii shall be Post doc/Project fellow/ Research Scholar)	Internal supervisor	
	Assistant supervisor	
FOR OFFICE USE: Remarks by Project advisory Committee		
External Guide / Supervisor		
Internal Guide / Supervisor		
Proposed Assistant Guide / Supervisor		
Dated signature of HOD		

DEPARTMENT OF COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

UNIVERSITY OF KERALA

PART-B: PROJECT PROGRESS REPORTING DOCKET

Regular documentation is required to ensure that meaningful monitoring and management of project work is carried out. This docket is to be submitted thrice during project period as indicated in **Weekly Planner in Part-C**. You are also encouraged to record key discussions and minute them as appendix.

Docket Submission Details

Serial No of Submission	
Date of Submission	
Dated Signature of Candidate	

Mark the Start Date & Estimated Project Submission Dates below (Put tick mark on column)

YEAR												

1	Name of Student:
2	Name(s) of Guide(s) :
3	No. of weeks elapsed after beginning of the project:
4	List 2 keywords to describe the project:
5	List couple of papers published in journals which directly relate to the area of proposed work. 1. 2.
6	List 2 areas of basic knowledge that are directly related to the project work. 1. 2.

7	List 2 tools/ skills required to do the project. 1. 2.
8	List 2 prominent researchers in the field who are currently active in the area. 1. 2.
9	List 2 journals in which papers of this area are appearing 1. 2. List some books which deal with basics of your project area. 1. 2.
10	List 2 upcoming conferences you would like to attend. 1. 2.
11	List 2 strengths you have to do this project. 1. 2.
12	List 2 areas of weakness in doing this project (*also say how you propose to overcome them*). 1. 2.
13	List a possible title of paper that you could publish on your project.
14	List 2 possible titles of your thesis. 1. 2.

15	List the possible titles of your thesis chapters.
16	List 2 challenges you are facing: 1. 2.
17	List 2 deliverables of your project. 1. 2.
18	Write in one sentence the up to date Synopsis of your project.
19	Write in one paragraph (4-5 sentences), the up to date Synopsis of your project.
20	Attach hand out / print out of the following PPTs (Appendix). Indicate version and date in the first page. 1. 1 slide PPT describing your project (This should capture the essence of the work in compact graphics – a sample is available on request) 2. 10 slide PPT describing your project.
21	What are your major achievements in the reporting period?
22	What are your immediate milestones and estimated dates to reach them?

23	Papers read in the last month with a 2-3 sentence comment in your own words and also mentioning the open questions identified.
24	Lectures / Conferences / Training attended with 2-3 sentence summary/outcome.
25	Write an appreciation of your work during last month.
26	Write a criticism of your work during last month.
27	Describe your recent library usage. Key subject books you read: 1. 2. Key non-subject books you read: 1. Key online resources you read: 1. 2.

28	Is there any query you would like to make to your supervisor?
29	What are some of the issues (*intellectual as well as otherwise*) you face in project? (*Also mention personal circumstances which prevent full output.*) Rate your motivation level now : poor ☐ Average ☐ Good ☐ Very Good ☐ Excellent
30	Is there some specific query/request that you wish to make to your guide?

RATING OF PROGRESS (BEST IS 10 STARS * * * * * * * * * *)	
Your Own Rating of Progress since the last report	
Guide's Rating of Progress since the last report	
Your own Rating of **Total Progress**	
Guide's Rating of **Total Progress**	

Official Data:

No.	Item	Data
1	Days and dates of absence during reporting period	
2	Have you done bi weekly CD backup?	
3	Are you keeping a lab notebook?	

Part C: General Guidelines

1) Students should maintain Lab Note Books; with one page brief report for each day. For example if you spend time in Library, you should mention journals / books read. On web, note down URLs, while doing experiments note settings and intermediate results. Lab note books shall form a component for evaluation and shall be presented to the external examiner, if demanded.
2) Students are expected to spend a minimum of clear (that is, excluding phone calls, face-book, tea/ lunch break etc) 8 hours per day, ideally 10-12 hours. This is sure to reflect on the quality and quantity of work.
3) Students should photocopy/ print important reference material and file them for constant reference and make notes on them as they read. They are expected to read key references many times over (10 or even 20 times is not unexpected). The collection of reference materials should be produced during viva / discussion with supervisors, if required.
4) Students have to submit 3 Project docket reports along with Work Reports (about 5 pages) as indicated in the weekly planner. Along with it, draft chapters as indicated should also be submitted.
5) Thesis writing should be done in a distributed manner and not in haste after finishing work. To obtain quality feedback, submit draft chapters regularly as indicated in week plan.
6) Avoid copying text from net or from any other resources. Understand the concept and write it in your own words.
7) Font should be 'Cambria'/ any font which is used in dissertation. For text, font size should be 12 and for main headings font size can be 14 (bold) and for sub headings 12 (bold).
8) Page margins top : 2 cms, bottom, 2 cms", left 3 cms, right 2cms
9) Line spacing can be double and paragraph spacing before: 6 pt, after: 6pt
10) All figures/ pictures/ graphs should be labeled in the following way. Figure label must start with 'Fig.' followed by 'Serial no.' (based on the chapter). For example for the second figure in chapter 4, the figure no. should be 'Fig. 4.2: Description of the figure'.
11) All table names should start with 'Table.' Table number (according to the chapter). That is Table No.: Description of the table'. Font size of all labels (table and figure) should be 11.
12) Font size inside the table should be 12.
13) Page number should appear in the bottom centre position of the every page. Page no. of the first page of chapter 1 should be 1. Font size is 9.
14) Project Report should conform to the Green Charter of the University of Kerala.

WEEKLY PLANNER

Week	Date	Documentation Activity of Student	Activity of Supervisor/ Assistant supervisor	Remarks
Week 1				
Week 2				
Week 3				
Week 4		**Submit Project docket 1 + Draft of chapter 1 and 2+ work report 1**		
Week 5			**Issues a project review report**	
Week 6		**Revise chapter 1 & 2**		
Week 7				
Week 8		**Submit Project docket 2 + Partial Draft of chapter 3 and 4 + work report 2**		
Week 9			**Return drafts with detailed review**	
Week 10		**Revise chapter 3 & 4**		
Week 11				
Week 12		**Submit project docket 3+ dream Synopsis, partial result + work report 3**		
Week 13				
Week 14		**Submit 90 % complete draft of thesis* and Synopsis final* Pre submission docket +peer review**	**Send out final project checklist**	
Week 15		**Submission of Thesis**		
Week 16		**Preparation of OUP format paper & PPT & peer review**	**Review of paper & PPT**	
Report back to Department				

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PART-D: FORM FOR STUDENT PEER REVIEW OF PROJECT

1.	Your Name:	
2.	Title of project you are reviewing:	
3.	Name of Project student:	
4.	Give five positive aspects of the project. 1. 2. 3. 4. 5.	
5.	Give 5 aspects that need improvement 1. 2. 3. 4. 5.	
6.	Do you find the quantum of work comparable to y own?	YES/NO
7.	Do you find the quantum of work comparable to y own?	YES/NO
8.	Do you find the quantum of references compared your own?	YES/NO
9.	What are your suggestions for enhancing the quality of work?	
10.	Are there books/web resources/journal papers/persons that you would like to suggest to the project student for drawing knowledge?	

Date:

Signature:

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PART-E: INTERIM REVIEW REPORT BY INTERNAL SUPERVISOR

Name: Date:
Title of Project:

Quick Remarks	
1. Satisfactory Progress?	Yes/No
2. Technical correctness of methodology?	Yes/No
3. Sufficient use of knowledge resources (References)?	Yes/No
4. Good library usage?	Yes/No
5. Good work habits?	Yes/No
6. Satisfactory Keeping of lab Note Book?	Yes/No
7. Student Peer Review and use?	Yes/No
8. Satisfactory Attendance?	Yes/No
Remarks on Technical Progress of Work:	
General Advices on bettering project work:	
Specific reply to questions, if any, raised by student in Progress Report	

Any '**To-Do'** before Next Review:

Counter signed by Internal Supervisor Signed by Asst. Supervisor

Head of the Department

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PART-F: M.Sc. PROJECT SELF EVALUATION REPORT
(DATA TO BE FILLED-IN BY STUDENT)

1. Name of student:	
2. Register Number:	
3. Title of the Thesis:	
4. Supervisors: a) Internal: b) External: c) Assistant:	
5. Total no. of pages in Dissertation	
6. No of pages of the final chapter(Conclusions and future work):	
7. Total no of references: No. of journal cited:	
8. Have you taken peer reviews from other students? Have they been used :	YES/NO YES/NO
9. Give three key achievements in your project work: 1. 2. 3.	
10. Give three weeks aspects of project work and dissertation.	
11. If you were asked to say in one sentence, the abstract of your project, what would you say?	
12. What were the unanswered questions you identified at the end of the project?	
13. Have you attended any seminar/references? Give details.	

14. Have you ensured that every sentence in your dissertation is your own?	**YES/NO**
15. Have you cited any long paragraph as such with/without giving references?	**YES/NO**
16. Are all images, table, etc. your own or sources cited clearly?	**YES/NO**
17. Have you spell checked the whole dissertation.	**YES/NO**
18. Have you verified the format of the dissertation based on instructions?	**YES/NO**
19. Have you separately checked the punctuation formatting, including reference section?	**YES/NO**

Dated Signature

Enclosures to be provided by students

1. *One page synopsis including key references* ***2.*** *Lab Notebook.* ***3.*** *Three project progress reports and corresponding assistant supervisors review report* ***4.*** *Peer review reports by fellow students*

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PART-G (i): M.Sc. FINAL EVALUATION REPORT FOR BIN-D-442

(2-6 TO BE FILLED IN BY BOTH EXAMINERS AND AVERAGE AWARDED)

Name	
Register Number	

EVALUATION COMPONENTS & SUB COMPONENTS (Weightage out of 100 in brackets)	**GRADE** A-Outstanding, B-Excellent, C-Good, D-Average, E-Below, F-Fail.
1. PROJECT MANAGEMENT (10)(To be given by internal Supervisor)	
Lab Note Book is regular & detailed (2.5)	**A/B/C/D/E/F**
Detailed & Precise Progress Reports (2.5)	**A/B/C/D/E/F**
Regular Peer Review/Supervisor review & Action (5)	**A/B/C/D/E/F**
2. PROJECT REPORTING (10)	
Scientific Reporting Standards, Formatting (5)	**A/B/C/D/E/F**
Citing Practice, Avoidance of Plagiarism (5)	**A/B/C/D/E/F**
3. TECHNICAL WORK (35)	
Quantum of work (10)	**A/B/C/D/E/F**
Meetings Objectives (10)	**A/B/C/D/E/F**
Demonstration of Results (15)	**A/B/C/D/E/F**
4. SCHOLARSHIP (15)	
Demonstration of Critical Analysis (5)	**A/B/C/D/E/F**
Contextualizing the work (5)	**A/B/C/D/E/F**
Knowledge as demonstrated in Viva (5)	**A/B/C/D/E/F**
5. COMMUNICATION SKILLS (10)	
Presentation Skills in Viva (5)	**A/B/C/D/E/F**
Use of language in Dissertation (5)	**A/B/C/D/E/F**
6. Publishing (15)	
Summary of Project in Research paper format (5)	**A/B/C/D/E/F**
Publication/Attempt for Publication in journals/conferences approved by the Department council (10)	**A/B/C/D/E/F**
7.Weightage for project done in external organization (5)	
Total Marks (out of 100*)	

Internal Examiner External Examiner

***Converting Grades to Marks**

MAX	A	B	C	D	E	F
2.5	2.5	2	1.5	1	0.5	0
5	5	4	3	2	1	0
10	10	8	7	5	3	0
15	15	12	9	6	4	0