B Tech Course Structure 2017-18 BI

JES					
4 year BTech New Approved Curricula for Bioinformatics wef 2017-18 batch					
		BTech I semester (B1)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1	PD	Presentation and communication skill	3	3	
2	MA	Basic Math-I/ **OR**	4	4	
	BT	Fundamental Biology	3	3	
3	PH	Basic Engineering & Applied Physics	4	4	
4	BI	Cell and Molecular Biology	4	4	
5	CI	Introduction to Computers & Programming	4	4	
6	PH	Physics Lab-I	2	1	
7	BI	Introduction to Biocomputing Lab	2	1	
8	CI	Introduction to Computers & Programming Lab	4	2	
9	BI	Biological Database Systems Lab	2	1	
10	BI	Cell and Molecular Biology Lab	2	1	
11	BT	Fundamental Biology Lab	2	1	
		Total	**31**	**25**	

JES					
4 year BTech New Approved Curricula for Bioinformatics wef 2017-18 batch					
		BTech II semester (B2)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1.	PD	Group and Cooperative Processes	3	3	
2.	MA	Basic Math-II	4	4	
3.	BI	Molecular Genetics	4	4	
4.	BI	Structural Biology	4	4	
5.	CI	Data Structures	4	4	
6.	BI	Molecular Modeling Lab	4	2	
7.	BI	Structural Biology Lab	2	1	
8.	CI	Data Structures & Computer Programming Lab	4	2	
9.	BI	Molecular Genetics Lab	2	1	
			31	**25**	
		Total			

JES

4 year BTech New Approved Curricula for Bioinformatics wef 2017-18 batch

		BTech III semester (B3)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1.	PD	Managerial Economics	3	3	
2.	MA	Probability & Statistics	4	4	
3.	CI	Database Systems	4	4	
4.	BI	Biological Computation	4	4	
5.	BI	Microbiology & Immune System	4	4	
7.	CI	Database Systems Lab	2	1	
8.	BI	Biological Computation Lab	4	2	
9.	BI	Microbiology & Immune System Lab	2	1	
10.	BI	Linux Lab	4	2	
		Total	**31**	**25**	

JES

4 year BTech New Approved Curricula for Bioinformatics wef 2017-18 batch

		BTech IV semester (B4)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1.	PD	Financial Management	3	3	
2.	MA	Biostatistics	4	4	
3.	BI	Genetic Engineering and Genomics	4	4	
4.	CI	Object Oriented Programming	4	4	
5.	BI	Programming Languages for Bioinformatics	4	4	
6.	GE	Environmental Studies	3	3	
7.	BI	Genetic Engineering and Genomics Lab	2	1	
8.	CI	Object Oriented Programming Lab	2	1	
9.	MA	Bio-Statistics Lab	2	1	
10.	BI	Programming Languages for Bioinformatics Lab	2	1	
		Total	**30**	**26**	

JES

4 year BTech New Approved Curricula for Bioinformatics wef 2017-18 batch

		BTech V semester (B5)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1.	PD	Social & Legal Issues	3	3	
2.	CI	Elective from CS Department	4	4	
3.	BI	Structural Bioinformatics	4	4	
4.	BI	Computational Genomics	4	4	
5.	BI	Scripting Languages for BI	4	4	
6.	CI	Fundamentals of Algorithms Lab	2	1	
7.	BI	Structural Bioinformatics Lab	2	1	
8.	BT	Computational Genomics Lab	2	1	
9.	BI	Advanced Database System Lab	2	1	
10.	BI	Scripting Languages for BI Lab	2	1	
11.	BI	Biomedical Informatics Lab	2	1	
12		Minor Project-I		2	
		Total	31	27	

JES

4 year BTech New Approved Curricula for Bioinformatics wef 2017-18 batch

		BTech VI semester (B6)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1.	PD	Project Management/Open Elective	3	3	
2.	BI	Machine Learning for Bioinformatics	4	4	
3.	BI	Computer Aided Drug Design	4	4	
4.	BI	Data Warehousing and Mining for Bioinformatics	4	4	
5.	BI	Advanced Algorithms for Bioinformatics	4	4	
6.	BI	Machine Learning for Bioinformatics lab	2	1	
7.	BI	Computer Aided Drug Design Lab	4	2	
8.	BI	Data Warehousing and Mining for Bioinformatics Lab	2	1	
9.	BI	Advanced Algorithms for Bioinformatics Lab	2	1	
10.	BI	R Language Lab	2	1	
11.		Minor Project-II		2	
		Total	**31**	**27**	

JES

4 year BTech New Approved Curricula for Bioinformatics wef 2017-18 batch

BTech VII semester (B7)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1.		Professional Dev – VII/Open Elective/Moocs	3	3	
2.		DE-I	3	3	
3.		DE-II	3	3	
4.		DE-III	3	3	
	BI	Project Part-I	16	08	
		Total	**28**	**20**	

JES

4 year BTech New Approved Curricula for Bioinformatics wef 2017-18 batch

BTech VIII semester (B8)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1.		Professional Dev – VIII Open Elective/Moocs	3	3	
2.		DE-IV	3	3	
3.		DE-V	3	3	
4.		DE-VI	3	3	
	BI	Project Part-II	16	8	
		Total	**28**	**20**	
		Total Credits in B.Tech.Bioinformatics		**195**	
		List of Electives			
		(To be updated from time to time)			
		MEDICAL			
	BT	Antibody Engineering Technologies			
	BT	Stem Cells & Regenerative Medicine			
	BT	Vaccine Production			
		FOOD AND AGRICULTURE			
	BT	Food Processing & Engineering			
	BT	Industrial Plant Tissue Culture			
	BT	Plant Biotechnology			
	BT	Traditional Bioprocesses			

		INDUSTRIAL			
	BT	Bioenergy and Biofuels			
	BT	Bioprocess Modelling and Simulation			
	BT	Bioprocess Optimization & Upscaling			
	BT	Bio-resources & Industrial Products			
	BT	Environmental Biotechnology			
	BT	Manufacturing Processes & QC			
	BT	Nano Biotechnology			
	BT	QC Analysis & Management			
		OTHERS			
	PH	Biosensors			
	PH	Nanoscience & Nanotechnology			
	BT	IPR and Bioethics			
		Credit Summary	**Credits**		
		Sem1	25		
		Sem2	25		
		Sem3	25		
		Sem4	26		
		Sem5	27		
		Sem6	27		
		Sem7	20		
		Sem8	20		
		Total	**195**		

B.TECH. BIOINFORMATICS

SYLLABUS

FUNDAMENTAL BIOLOGY

Course code: 13B11BT111

(Core Course)

Credits 3
Lectures 2 Tutorials 1 Practical 0

Pre-requisites: X^{th} class general biology.

Objective:
This is basic foundation biology course for the students having mathematics background.The objectives are to familiarize students with basics of biology and different kingdoms, their characteristics, and different biomolecules such as carbohydrates, lipids, proteins. The course is also designed to familiarize the students with the various biological processes at molecular level like replication, transcription and translation.

Course Assessment:

Exam.	Marks	Duration	Course Covered
T1 Test	**15**	**1 hr.**	**Unit 1-3**
T2 Test	**25**	**1.5 hrs.**	**Unit 1-7**
End Term	**35**	**2 hrs.**	**Whole Syllabus**
Teacher Assessment (Based on Assignments, quizzes etc.)	**25**	**Whole Semester(Quiz, short presentations)**	**Inform class time t time**
	Total 100		

Course Outcomes:
CO I: After this course completion, students coming from mathematics background would have fundamental knowledge of the organism.
CO II: Students should able to understand the characteristics of an organism and their importance in Biotechnology
CO III: Students will have basic knowledge of DNA, RNA, Protein, Carbohydrate and Proteins

Topics Covered:

S. No.	Unit		No. of Lectures

1.	Biological systems and their organizations:	Overview of living system and their different life forms, Plants, animals and micro-organisms: their similarities and differences	2
		Basic biological processes, hierarchy of living system from individual to molecular level. Cells and their organizations, basics of cell membrane	3
2.	BIOMOLECULES: Building blocks of living system	Carbohydrates: Chemical structures, nature, properties, Classification and Importance in Biological Systems.	3
		Lipids: Structure, Classification, Properties and Function.	3
		Amino acids and Proteins: Structure properties, classification, and function.	4
		Enzymes: Classification, Characteristics	2
		Nucleic acids: Nitrogenous bases, nucleosides and nucleotides, DNA & RNA structures, rRNA, tRNA and mRNA.	4
3.	BIOLOGICAL CLASSIFICATION:Five Kingdom Classification	Taxonomy based classification overview: Merits and demerits, Characteristics of the Five Different Kingdoms	1
		KINGDOM MONERA: Archaebacteria and Eubacteria. Basic biology of different bacteria of different shapes,	2
		KINGDOM PROTISTA: Chrysophytes, Dinoflagellates, Euglenoids, Slime Moulds, Protozoans	1
		KINGDOM FUNGI: Different classes of fungi with life cycles. Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes,	2
		KINGDOM PLANTAE: Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms, Plant Life Cycles and Alternation of Generations	2
		Kingdom Animalia: Basis of classification, Level of organization and their Classification. Basic life functions of humans	2
4	Flow of information in biological system	Central Dogma, DNA replication and Transcription	4
		Translation, initiation, elongation and termination.	2
5	Molecular details of Biological	Overview of metabolism	1

	processes	Molecular respiration and energy production.	3
6	Biology and Bioinformatics	Role of above mentioned processes and structure in Bioinformatics	1
		Total	**42**

Suggested text book:

1. Neill, Campbell (1996). Biology; Fourth edition.The Benjamin/Cummings Publishing Company. p. 309,310. ISBN 0-8053-1940-9.
2. Stryer, Lubert (2002). Biochemistry; Fifth edition. W. H. Freeman and Company.
3. Principles of Biochemistry [5th edition], Lehninger.pdf

Reference books

1. Lodish H, Berk A, Zipursky LS, Matsudaira P, Baltimore D, Darnell J (2000). Molecular Cell Biology. W. H. Freeman and Company

Fundamental Biology lab.

Course Code: 13B17BI171

Course Credits: 1

Objective:

The objective of this course is to familiarize the students with basic biology laboratory techniques specifically used in modern biotechnology area.

Learning outcome:
At the end of the course, the student will be able to identify and analyze various applications in the field of biotechnology.

S.NO.	TITLE	Allotted Hours
1.	Introduction to basic laboratory practices.	2
2.	Introduction to simple and compound microscopy	2
3.	To study the Biosafety cabinet (BSL-2) used in microbiology lab	2
4.	Different sterilization method in laboratory practices	2
5.	To prepare a smear of bacterial culture.	2
6.	Serial dilution of bacterial culture	2
7.	Introduction to simple and differential staining (gram staining)	2
8.	Staining of unicellular eukaryote	2
9.	Microscopic examination of Algae (chlorella)	2
10.	Microscopic examination of fungi	2
11.	Measurement of concentration of a given solution. (Calculation of Molarity, Normality & Molality)	2
12.	Calibration of pH meter and adjustment of pH of given solution	2
13.	To prepare a temporary mount of onion cell	2
14.	Introduction to spectrophotometers	2
15.	Preparetion of standard curve	2

Methodology: Students will do various experiments in Undergraduate lab2.

Evaluation Scheme:

Midterm Evaluation	40
Final Evaluation	40
Regular lab work	05
Attendance	05
Lab record	10

Cell and Molecular Biology

Course code: 13B11BI112
Credits: 4, L3 T1 P0

Pre-requisites: Knowledge of Biology

Introduction: Cells are the fundamental unit of life, composed of billions of molecules: DNA, RNA, proteins, glycans, lipids, and small molecules that have defined molecular properties and biological activities. Each cell is able to respond to its environment and to communicate with other cells to create tissues, organs, and whole organisms. How do these molecular components assemble to produce a cell with the ability to carry out distinctive functions in response to its surroundings that yield the property of life?

Cell and Molecular Biology is an interdisciplinary field that bridges the fields of chemistry, structure and biology as it seeks to understand life and cellular processes at the molecular level. In the midst of the "omics" era that is producing vast databases cataloguing the molecular components of cells, it is ever more important to discover the basic mechanisms that allow cells to have differentiated properties and coordinate the activities that form the essential systems that define a living cell. This will be crucial for understanding the basis of human disease. The "omics" era will continue to be one of rapid growth and discovery that will continuously expand the potential of Cell and Molecular biology to get answers. Through the application of ever more powerful tools, we are rapidly placing the growing compendium of cellular molecules in their functional context within the cell, and the integrated functions of cells in our bodies to address the most central problems in human health development of medicines for the 21st century. It could not be a more exciting time.

1. Course Objectives (Learning Goal):
1. The objective of the course is to equip students with a detailed knowledge of molecular structure and components of the cell and to understand how molecules interact within the cell to promote proper growth, division, and development

2. Course Outcomes:

CO I: Able to describe the chemical components of the macromolecules of life and their functions and the structural differences between prokaryotic and eukaryotic cells or between plant and animal cells

CO II: Understand how molecular machines within the cell are constructed and regulated so that they can accurately copy, repair, and interpret genomic information.

CO III: Write, discuss or critique about emerging biology-related topics individually or in groups

3. Syllabus topics for BI (Cell and Molecular biology)

Units (Course contents)	No. of lectures
1. BIOLOGICAL CLASSIFICATION Introduction to the organization of eukaryotic and prokaryotic cells.	3
2. BIOMOLECULES: Carbohydrates: Chemical structures, nature, properties, Classification and Importance in Biological Systems. Lipids: Structure, Classification, Properties and Function.	2+3
3. Amino acids: Classification, properties, structure, nature. Proteins: Classification, Structure and Function. Enzymes: Classification, Characteristics	3+2
4. Molecular details of the Cell (Cells and Genomes, Cell Chemistry and Biosynthesis, Proteins)	2+2
5. Structural functional significance of sub-cellular organelles (Mitochondria, chloroplast, Endoplasmic reticulum, Golgi apparatus, etc.).	3
6. Nucleic acids: Bases, nucleosides and nucleotides, DNA & RNA structure, rRNA, tRNA and mRNA. Structural organization of DNA and Chromosomes, DNA Replication and Repair.	6
7. Protein trafficking, Protein synthesis; Protein sorting, transport and secretion.	5
8. Flow of information in biology (Central Dogma). DNA replication, DNA polymerases, Transcription,	6
9. Cellular transport across membranes; Exocytosis, Endocytosis and Receptor mediated endocytosis.	5

4. Evaluation:

Exam.	Marks	Weightage	Description
Test 1	1hr, 15 marks,	15	course covered upto

			T1 (topic covered under unit 1-3)
Test 2	1.5 hrs, 25 marks	25	course covered upto T2 including that covered upto T1(1-6)
Test 3	2 hrs, 35 marks,	35	Total syllabus.
Attendance + Quiz + Assignments	5+10+10=25 Quiz=4 (1st and last week	25	80% Attendance will get one marks, 95% or more will get 5 marks

5. Evaluation in classroom: The course will be taught in an interactive mode of learning wherein students will be made to ask frequent question in the lectures.

The course will emphasize to inculcate a zeal of developing independent thinking in conceptualizing and solving problems in the tutorials.

Cell and Molecular Biology laboratory

Course Code: 13B17BI172

Course Credits: 1

Objective:

The objective of this course is to familiarize the students with laboratory techniques specifically in microbiology and molecular biology area.

Learning outcome:
At the end of the course, the student will be able to identify and analyze various applications in the field of microbiology and biotechnology.

S.NO.	TITLE	Related theory course	Allotted Hours
1.	laboratory practices		2
2.	Introduction to Microscope	Unit-1	2
3.	To prepare slides of prokaryotic and eukaryotic cell to observe under microscope.	Unit-1	2
4.	Calculation of Molarity, Normality	Unit-2	2
5.	Carbohydrate estimation	Unit 2	
6.	To study the biosafety cabinet used in microbiology lab		
7.	Preparation of isolated single bacterial colony through serial dilution.	Unit-4	4
8.	To observe difference in cultured plate prepared in laminar air flow and open air	Unit-4	2
9.	General Instrumentations for lab. Practices; 1. pH meter	Unit-6	2
10.	2. Spectrophotometer		2
11	Introduction to agarose gel electrophoresis	Unit-6	2

12	Preparation of buffer for genomic DNA extraction and	Unt-8	2
13	Isolation of genomic DNA	Unit-8	2
14	Isolation of genomic DNA (continued)	Unit-8	2

Evaluation

Mid Term	25
Day to day performance	20
Teacher Assessment (Based on performance in expts, lab notebook etc.))	20
End Term Exam	35
Total	100

Suggested text book:

1. Harley – Prescott Laboratory exercises in Microbiology
2. Biotechnology Lab course : Jeffery M.Becker, Guy A. Caldwell, Eve Ann Zachgo
3. Biology 6th edition : Raven – Johnson
4. Campbell --- Biology 7th edition

Laboratory Manuals

Introduction to Biocomputing Lab

13B17BI173

Credits: 1

(Course Coordinator: Dr. Y. M. Ragothaman)

Introduction:

Introduction to Biocomputing Lab course is designed to connect with the basic fundamental knowledge of Biology. Here the students will be learning about basic computational tools/methods that will be frequently used in their four year B.Tech Bioinformatics course. They will also develop skills/approaches to perform computational analysis on the available biological data and its organization.

Course Objective:

- To familiarize, understand, and master the available computational tools for Bioinformatics.
- To develop skills to perform computational data analysis.

Learning Outcome:

CO I: Imparting fundamental knowledge of biocomputing with latest tools **CO II:** To understand and analyze computing power of biological data **CO III:** Strong knowledge of informatics with latest tools.

Topics covered and mapping to the theory course:

Lab	**Topic**	**Learning Outcomes**
1	Introduction to Bioinformatics, How most people use Bioinformatics	**CO I**
2	Introduction to NCBI and Uniprot	**CO I and II**
3	Expasy- A meta server tool	**CO II**
4	Multiple and Pairwise sequence Alignment of DNA and protein (Multalign, ClustalW, ClustalX)	**CO II and III**
5	Dot Plot and early version of sequence alignment of DNA and protein	**CO II and III**
6	Introduction to BLAST and its various flavors	**CO III**

7	Introduction to gene prediction tools	**CO I, II and III**
8	Working with RNA	**CO I, II and III**
9	PDB and visualizing protein structures (PyMOL and Rasmol)	**CO I, II and III**
10	Identifying Motifs using Prosite	**CO III**
11	Identifying Motifs using MEME	
12	Phylogenetic analysis using PHYLIP	**CO II and III**
13	Introduction to Systems Biology (E-cell)	**CO III**
	Total number of Labs: 13	

Teaching Methodology:

The course will be taught through short lectures and hands-on practicals. Specifically, the following will be implemented throughout the course.

- Short lectures in class that introduce the concept and problem in hand.
- Followed by short demonstration of what to do and what is expected.
- One on one question to students to ensure they understood the expectations and methods.
- Documentation in the form of lab notebook and online submissions

Evaluation Schemes:

The assessment and evaluation of Learning objectives and course outcomes will be done throughout the course, periodically. It will be implemented as follows:

- Evaluation of lab notebooks and assessment of student understanding of concepts.
- One on one counseling and assessment will be performed periodically to familiarize the student's strength and weaknesses.
- Exams will be a mix of computational experiments along with viva questions.

	Examinations	**Marks (%)**

a.	Day to day work based on: i. Attendance and discipline in lab ii. Learning laboratory skills, and comprehensive understanding and application about the experiments iii. Laboratory record	**60** 15 30 15
b.	Mid-semester lab Exam– (viva/test)	**20**
c.	Project	**15**
d.	End Semester lab Exam– viva/test	**20**
	Total	**100**

6. Text books:

1. De Robertis, E. D. P. and De Robertis, Jr. E. N. F. "Cell and Molecular Biology". Lea and Febiger, New York
2. Karp, J. "Cell and Molecular Biology, Concepts and Experiments" Jhon Wiley and Sons Inc. USA
3. Stryer, Lubert (2002). Biochemistry; Fifth edition. W. H. Freeman and Company.
4. Lehninger "Principles of Biochemistry"

Reference books:

1. Lodish H, Berk A, Zipursky LS, Matsudaira P, Baltimore D, Darnell J (2000). *Molecular Cell Biology*. W. H. Freeman and Company
2. Molecular Biology of the Cell Alberts, B., et al. 4th edition (2002) Garland Science
3. Essential Cell Biology Alberts, B., et al; 3rd edition (2010) Garland Science
4. Molecular Cell Biology Damell Jr. J., Lodish, H and Baltimore, D. Scientific American Inc., New York
5. Neill, Campbell (1996). Biology; Fourth edition. The Benjamin/Cummings Publishing Company. p. 309,310. ISBN 0-8053-1940-9.

Cell and Molecular Biology lab

13B17BI172

Course Credits: 1

Objective:

The objective of this course is to familiarize the students with laboratory techniques specifically in microbiology and molecular biology area.

Learning outcome:
At the end of the course, the student will be able to identify and analyze various applications in the field of microbiology and biotechnology.

S.NO.	TITLE	Related theory course	Allotted Hours
1.	laboratory practices		2
2.	Introduction to Microscope	Unit-1	2
3.	To prepare slides of prokaryotic and eukaryotic cell to observe under microscope.	Unit-1	2
4.	Calculation of Molarity, Normality	Unit-2	2
5.	Carbohydrate estimation	Unit 2	
6.	To study the biosafety cabinet used in microbiology lab		
7.	Preparation of isolated single bacterial colony through serial dilution.	Unit-4	4
8.	To observe difference in cultured plate prepared in laminar air flow and open air	Unit-4	2
9.	General Instrumentations for lab. Practices; 1. pH meter	Unit-6	2
10.	2. Spectrophotometer		2
11	Introduction to agarose gel electrophoresis	Unit-6	2
12	Preparation of buffer for genomic DNA extraction and	Unt-8	2
13	Isolation of genomic DNA	Unit-8	2

14	Isolation of genomic DNA (continued)	Unit-8	2

Evaluation

Mid Term	25
Day to day performance	20
Teacher Assessment (Based on performance in expts, lab notebook etc.))	20
End Term Exam	35
Total	100

Suggested text book:

5. Harley – Prescott Laboratory exercises in Microbiology
6. Biotechnology Lab course : Jeffery M.Becker, Guy A. Caldwell, Eve Ann Zachgo
7. Biology 6th edition : Raven – Johnson
8. Campbell --- Biology 7th edition

Laboratory Manuals

Biological Database Systems Lab
13B17BI174

Credits 1

Prerequisite: None

Objective: Students will be introduced to various databases available for storage and management of biological data. Students will be exposed to various skills necessary for design and implementation of databases for addressing problems relating to storage & retrieval of biological data.

Evaluation Schemes:

Exam / Activity	**% of Marks**	**Duration**	**Coverage / scope**
Day to day work (i) Attendance (ii) Quantity & Quality of Experiments including Performed, Learning laboratory Skills and handling Laboratory Equipment, Instruments, Gadgets, Components, Materials and Software etc. (iii) Laboratory record	60 % (15%) (30%) (15%)	Entire Semester	Entire semester
Mid Semester lab-viva/test	20 %	2 Hour	Syllabus covered up to mid semester
End Semester lab-viva/test	20 %	2 Hour	Entire semester

Learning Outcome: By the end of the course a student shall acquire ability to -

i. Select appropriate database & use specific search criteria for retrieval of required biological data.
ii. Understand the structure & retrieval mechanism of major biological databases.

Name of the Experiments (Topics to be covered):

S No.		**Title of the Experiment**	**Lab Hours**
1.	a.	To explore various biological databases with DNA sequences	2

1.	b.	To get acquainted with ensemble genome database project.	2

B.Tech 2nd Sem

10B11BI411 **MOLECULAR GENETICS** **(Core *Course*)**

Credits 4

Lectures 3 Tutorials 1 Practical 0

Student Task:

i. Before each lab document pertaining details for it will be posted in the lab folder at \\172.16.73.6\. Students are advised to check the same.

ii. Lab instructor will discuss the theoretical details (if any) and give a demo for topic to becovered during a lab session.

iii. Each lab will have student task associated, that needs to be submitted by the givendeadline.

iv. Students should ensure they have made all the lab submissions before 1 week of finalexamination. Any submission done afterwards will not be evaluated.

Pre-requisites: Basic Biology

Objectives

The objective is to study the fundamental concepts of molecular genetics. Students should be able to design, analyze and interpret basic experiment in molecular genetics/biology.

Course Assessment:

Mid Term Test	30
End Term Test	45
Teacher Assessment (Based on Assignments, quizzes, presentation etc.)	25
Total	100

Course Outcomes:

COI: able to understand basic concepts of molecular genetics.

COII: describe and understand the structure of DNA and RNA, Genetic Code, how DNA is replicated and RNA is translated into proteins.

COIII: able to understand how gene expression is controlled and apply this knowledge to design, analyze and interpret basic experiments in molecular genetics/biology.

Topics Covered:

Molecular genetics an overview; Cell division: roles of cell division, types of cell division, chromosome, phases of cell cycle, cell cycle check points, mitosis and meiosis, Mendelian genetics: Mendel's Laws, monohybrid and dihybrid cross, test and back cross, Medel's conclusions, Gene interactions: epistasis, complementary, duplicate genes; Linkage mapping and Recombination: Molecular mechanisms, complete and incomplete linkage, recombination frequency, gene mapping and recombination frequency, genetic and physical maps; Gene Mutation and genetic disorder, Nucleic acids: Structure of DNA and RNA, Chargaff's rules, A, B and Z forms of DNA, types of RNA, DNA supercoiling and mechanisms; Central Dogma, DNA replication: Both prokaryotic and eukaryotic, model of replication, experimental demonstration to prove semi-conservative model of DNA replication, modes of replication, detailed mechanisms of replication; Transcription: Prokaryotes and Eukaryotes, details of steps initiation, elongation and termination; Gene regulation: Prokaryotic and Eukaryotes, positive and negative control, Operon model - *lac* and *trp* models, anti-sense RNA, riboswitches, ribozymes, methylation, acetylation and histone modification in gene regulation ; genetics code; post transcriptional modifications: prokaryotes and eukaryotes, RNA capping, RNA tailing, RNA splicing, RNA editing, Protein Synthesis: Both prokaryotes and eukaryotes.

Text Books

- Molecular cell biology, Fifth edition- Harvey Lodish, Arnold Berk, Lawrence Z, Paul M, David B, and James D.
- Genes VIII/IX-Benjamin Lewin

10B17BI471 **MOLECULAR GENETICS Lab** *Core Course*)

Credits 1

L 0 T 0 P 2

- Molecular biology of the gene, Fifth edition: James D. Watson, Tania A. Baker, Stephen P.Bell,Alexander Gann, Michael Levine, and Richard Losick

Pre-requisites: Basic Biology, molecular genetics/biology

Objective:

The objective is to give hand on training to the students about various techniques applied to molecular genetics, associated terminology and concepts.

Course Assessment:

Mid Term Test	30
End Term Test	45
Teacher Assessment (Based on performance in expts., lab notebook, etc.)	25
Total	100

Course Outcomes:

COI: After this course students would have hands on training for various molecular genetics techniques and link practical knowledge to theoretical.

COII: Able to design, analyze and interpret experiments related to molecular genetics/biology.

COIII: Able to isolate, purify and quantitate DNA from various sources, design PCR primers, run PCR assay.

Topics Covered:

1. To isolate Genomic DNA from plant samples.
2. To perform Agarose gel electrophoresis of isolated DNA.
3. To prepare genomic DNA from bacteria.

4. Isolation of DNA from human blood.
5. To isolate plasmid DNA from bacteria.
6. To quantitate purified DNA
7. Primer Designing and Calculation of Tm for Oligonucleotides.
8. To amplifiy DNA fragment using Polymerase Chain Reaction.
9. To perform restriction digestion of PCR amplified DNA.
10. To determination base composition of DNA by ultraviolet spectroscopy.
11. To elute DNA from Agarose Gel.
12. To perform SDS-Polyacrylamide Gel Electrophoresis (SDS PAGE).
13. Isolation of Total RNA by Trizol.
14. To perform gel electrophoresis of RNA.

Structural Biology

COURSE CODE: 10B11BI211

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

To visualize, analyze and compare structures of proteins and nucleic acids (DNA), and their subunits.
To identify and understand similar structural units (folds and domains) in proteins those have different functions.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the relationship between protein structure and its function.	Familiarity
CO-2	Understand the methods of characterizing protein's structure using X-ray and NMR methods	Familiarity
CO-3	Implementation of bioinformatics tools in understanding protein structures. Understanding the classification of protein databases.	Usage
CO-4	Introduction to protein engineering	Familiarity
CO-5	Understand the structural diversity in nucleic acids.	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Structural biology and its significance, Overview of amino acids and their various groups. Unnatural amino acids	1
2	Protein structure: Primary and Secondary Structure	2
3	Motifs &Supersecondary Structure, Tertiary Structure & Fold Types: Different types of secondary structures, Super-secondary structure and their classes, structural and functional domain, tertiary structures of proteins and their classes and sub-classes, Quaternary structures and cooperativity	2
4	Covalent and Non-covalent Forces: H-bonding, base stacking & hydrophobic interaction, paired interaction, torsion angle, solvent interaction in Protein, Role of free energy in Random and Natural states of polypeptide chain	4
5	Mechanisms of Protein Folding: Characterization of Folding Pathways and Mutagenesis Studies	2
6	Interactions of small molecule: Protein-Protein, Protein-DNA and Protein-RNA Interactions	2
7	Types of protein: Membrane Proteins, Fibrous Proteins, Metalloproteins, Carbohydrate Binding Proteins and Metalloenzymes: Structure and Function.	4
8	Protein Structure Determination by X-ray diffraction: Isolation, purification & crystallization of proteins, Basic principles of X-ray diffraction studies, Phase determination, calculation of Electron Density Map, Interpretation of Electron Density Map, Refinement of the Structures	4
9	Techniques: Circular Dichroism and Optical Rotation, Fluctuation Spectroscopy, Mass Spectrometry	2
10	NMR Techniques for protein structure determination: 1D NMR, 2D NMR (COSY & NOSY) Basic NMR Principles and Parameters, Vector & Product Operator Formalisms, Heteronuclear Correlation Experiments, Resonance Assignment Strategies, Protein Structure Determination	2
11	Protein secondary structure prediction: Principles of secondary structure prediction, Various secondary structure prediction tools (Chou-Fasman, GOR-IV, Neural network), Comparisons of various	4

	secondary structure prediction tools	
12	Structural Classification of Proteins: Principle of protein structure classification (VAST, DALI, SSP), Protein structure classification Database (SCOP, CATH, DSSP), Profiles and Protein Families	3
13	Protein Design: Structural Scaffolds and Enzymatic Function. Introduction to protein engineering, examples and applications of industrially important enzymes	3
14	Nucleic Acid Structures: DNA Tertiary structure(A- and B- DNA, Major and Minor Grooves of DNA, Z-DNA, Mechanism of specific base sequence recognization in B-DNA, Triple helix DNA, Tetraplex DNA, Introduction to RNA secondary structure	3
Total lectures		42

Suggested Text Book(s):

1. Introduction to Protein Structure, Carl Branden and John Tooze, Garland Publishing Inc., New York
2. Bioinformatics: sequence and Genome Analysis, DW Mount, Cold Spring Harbor Laboratory Press, 200
3. Creighton T.E. ed. Protein structure. A practical approach. (2004) Oxford University Press

Structural Biology Lab

COURSE CODE: 10B17BI271

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Thermodynamics and Chemical Processes, Microbiology

Course Objectives:

1. To visualize, analyze and compare structures of proteins and nucleic acids (DNA), and their subunits.
2. To develop the ability to design, predict, analyze and compare the protein structures.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	The fundamental concepts of structural biology (chemical building blocks, structure, superstructure, folding, etc.).	Familiarity
CO2	Structural databases and software for structure visualization.	Usage
CO3	Protein Structure Comparison.	Usage
CO4	Understanding the classification of protein databases. Protein structure prediction and assessment.	Assessment

List of Experiments

S.No	Description	Hours
1	Understanding Protein structures and Visualization	2
2	Drawing helical wheel for alpha helix	2

10B17BI471 **MOLECULAR GENETICS Lab** **(*Core Course*)**

Credits 1

L 0 T 0 P 2

3	Using Rasmol and PyMOL for 3-D visualization	2
4	Analysis of protein-protein interaction and protein-DNA interaction	2
5	Advanced PyMOL usage	2
6	Use of PDBsum for structural analysis	2
7	Protein-Ligand interactions: LIGPLOT	2
8	Secondary structure prediction methods	2
9	PROSITE - Protein signature patterns	2
10	Understanding Ramachandran plots and X-Ray Crystallography	2
11	RNA secondary structure visualization	2
Total Lab hours		22

Suggested/Resources:

1. Introduction to Protein Structure, Carl Branden and John Tooze, Garland Publishing Inc., New York
2. Bioinformatics: sequence and Genome Analysis, DW Mount, Cold Spring Harbor Laboratory Press, 200
3. Creighton T.E. ed. Protein structure. A practical approach. (2004) Oxford University Press

Pre-requisites: Basic Biology, molecular genetics/biology

Objective:

The objective is to give hand on training to the students about various techniques applied to molecular genetics, associated terminology and concepts.

Course Assessment:

Mid Term Test	30
End Term Test	45
Teacher Assessment (Based on performance in expts., lab notebook, etc.)	25
Total	100

Course Outcomes:

COI: After this course students would have hands on training for various molecular genetics techniques and link practical knowledge to theoretical.

COII: Able to design, analyze and interpret experiments related to molecular genetics/biology.

COIII: Able to isolate, purify and quantitate DNA from various sources, design PCR primers, run PCR assay.

Topics Covered:

1. To isolate Genomic DNA from plant samples.
2. To perform Agarose gel electrophoresis of isolated DNA.
3. To prepare genomic DNA from bacteria.
4. Isolation of DNA from human blood.
5. To isolate plasmid DNA from bacteria.
6. To quantitate purified DNA
7. Primer Designing and Calculation of Tm for Oligonucleotides.
8. To amplifiy DNA fragment using Polymerase Chain Reaction.
9. To perform restriction digestion of PCR amplified DNA.
10. To determination base composition of DNA by ultraviolet spectroscopy.
11. To elute DNA from Agarose Gel.
12. To perform SDS-Polyacrylamide Gel Electrophoresis (SDS PAGE).
13. Isolation of Total RNA by Trizol.
14. To perform gel electrophoresis of RNA.

3rd sem

Biological Computation

COURSE CODE: 10B11BI311

COURSE CREDITS: 4

CORE

L-T-P: 3-1-0

Pre-requisite: Introduction to Bioinformatics

Course Objectives:

To use & develop tools to curate (compare & analyze) biological data.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Basic algorithms used in Pairwise and Multiple alignments.	Usage
CO-2	Understanding the methodologies used for database searching, and determining the accuracies of database search.	Usage
CO-3	Application of probabilistic model to determine important patterns.	Familiarity
CO-4	Prediction of structure from sequence and subsequently testing the accuracy of predicted structures.	Usage
CO-5	Determine the protein function from sequence through analyzing data.	Usage
CO-6	Analysis and development of models for better interpretation of biological data to extract knowledge.	Assessment

Course Contents:

S. No.	Unit	Topics Covered	Contact Hrs.
1	Introduction	Meaning of sequence, sequence similarity, homology, meaning of alignment	1

2	Pairwise Sequence Alignment	Different scoring models, Substitution matrices (PAM and BLOSUM), Pairwise Alignment: Concept of Global and Local Alignment, Dot matrix method, Dynamic programming (Needleman-Wunsch algorithm, Smith-Waterman algorithm, Choosing of best scoring matrix, gap penalties, Significance of score, EVD, FASTA and BLAST algorithms, Information theory and Shanon Entropy	13
3	Multiple Sequence alignment	Multiple Sequence Alignment methods (MSA), Scoring of a MSA, Progressive (CLUSTALW and PILEUP), Iterative (Genetic) and Hidden Markov Model (HMM) methods of MSA, Local MSA (Profile and BLOCK analysis, and Pattern searching, and Expectation Maximization (EM) Algorithm (MEME) and Gibbs Sampler	6
4	Structural Alignment Tools and Protein Tertiary Structure Prediction	Structure alignment algorithms & Homology modeling	3
5	Markov Chains and HMM	Frequent words in DNA, Consensus word analysis, Transaction and emission matrix, Development of training set, CpG island prediction using HMM, Application of HMM in gene finding, and Multiple sequence alignment by HMM method.	7
6	Phylogenetic Analysis	Phylogenetic tree and terminology, different methods of Phylogenetic tree prediction: maximum parsimony, distance (UPGMA, NJ), maximum likelihood methods, bootstrapping, Jacknifing and Phylogenetic analysis by using Bayesian Network	7
7	RNA Structure	Terminology of RNA secondary structure, inferring	5

	Analysis	structure by comparative sequence analysis, RNA secondary structure prediction, Nussinov folding algorithm, energy minimization and Zuker folding algorithm	
	Total Number of Lectures		42

Suggested Text Book(s):

1. D.W. Mount *Bioinformatics: Genome and Sequence Analysis*: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
2. Ian Korf, Mark &Josaph: *BLAST*, Oreilly Publisher, 2003
3. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids.* Cambridge University Press.
4. A.D. Baxevanis& B.F.F. Oulette*Bioinformatics – A practical guide to the Analysis of Genes and Proteins*,2002, Willey International publishers.
5. M.J. Bishop and C.J. Rawlings (editors), *DNA and Protein Sequence Analysis---A Practical Approach* IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)
6. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Suggested Reference Book(s):

1. J. Setubal and J. Meidanis(1997) *Introduction to Computational Molecular Biology,* PWS Publishing Co.
2. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Other useful resource(s):

1.Link to topics related tocourse:

i. https://onlinecourses.nptel.ac.in/noc19_bt01/preview

Biological Computation Lab

COURSE CODE: 10B17BI371

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: Basic Programming Skills

Course Objectives:

1. To use and develop bioinformatics programs for comparing & analyzing biological sequence data to identify probable function.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Basic algorithms used in Pairwise and Multiple alignments.	Assessment
CO2	Understanding the methodologies used for database searching, and determining the accuracies of database search.	Assessment
CO3	Application of probabilistic model to determine important patterns.	Assessment
CO4	Prediction of structure from sequence and subsequently testing the accuracy of predicted structures.	Assessment
CO5	Determine the protein function from sequence through analysis of data.	Assessment
CO6	Analysis and development of models for better interpretation of biological data to extract knowledge.	Assessment

List of Experiments

S.No	Description	Hours

1	Overview of Practical classes conducted in the IInd Semester course of "Structural Biology" on RCSB, Visualization softwares, and tools related to secondary and tertiary structure predictions.	4
2	Different sequence formats such as FASTA, PIR, EMBL, PDB, etc. Different sequence databases, retrieval of sequences from those databases and different ways to store the sequences. Calculation of the score of a pairwise alignment by using a scoring pattern (Take Home).	4
3	Select a protein family for your mini-project and find out its superfamily. Also select another protein family which belongs to above superfamily and closer to your protein family.	4
4	Find out structural and functional information about above protein families and superfamily.	4
5	Write a program to align two sequences using Needleman-Wunsch algorithm?	4
6	Use EBI (European Bioinformatics Institute) Needle sequence alignment tool to align above two sequences and compare your result with that of Needle tool	4
7	(i) Use of BLAST on line server to retrieve sequences from a database (ii) Develop a program based on BLAST algorithm to carry out database search?	4
8	Use Clustaw software or on line server to align sequences from a family.	4
9	Develop a Multiple Sequence Alignment (MSA) program based on ClustalW algorithm.	4
10	Develop a program to identify motif from a set of sequences. Use on-line motif identification tools to predict motif in a set of sequences.	4
11	Use of Phylip package to infer phylogenetic tree in distance, maximum parsimony (MP) and maximum likelihood (ML)	4

	methods.	
12	Use of Phylip package to determine robustness of inferred tree determined by each method.	4
Total Lab hours		48

Suggested/Resources:

1. http://hmmer.org/.
2. https://blast.ncbi.nlm.nih.gov/Blast.cgi
3. https://www.genome.jp/tools-bin/clustalw
4. http://meme-suite.org/
5. http://evolution.genetics.washington.edu/phylip.html
6. https://www.rcsb.org/

Suggested Books:

1. Mount D.W. : Bioinformatics: Genome and Sequence Analysis: (2001), Cold Spring Harbor Laboratory Press, New York.
2. Korf Ian &Josaph Mark : BLAST, Oreilly Publisher, 2003
3. Durbin R., Eddy S., Krogh A. and G. Mitchison : Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.

Reference books:

1. Pevsner J. : Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, New York.
2. Baxevanis AD &Oulette BFF : Bioinformatics – A practical guide to the Analysis of Genes and Proteins, Willey International publishers.

Microbiology and Immune System

COURSE CODE: 14BI1BI311

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: None

Course Objectives:

2. The objective of the course is to develop an understanding of basic microbiological and immunological principles and be able to understand different classes of disease causing microorganisms and how they activate and counter-act the host immune system.
3. To provide an understanding of the principles of microbiology and immunology and techniques that can serve as a platform for other courses built on biological concepts.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Usage of scientific terminologies to describe & express fundamental concepts in Microbiology and Immunology	Familiarity
CO-2	Able to apply basic principles to understand host-microbe relationship in different Infectious diseases.	Assessment
CO-3	Able to connect and integrate the knowledge obtained for applications related to Microbes, their tools and database.	Usage
CO-4	Able to connect and integrate the knowledge obtained for applications related to Immunology, Vaccines and related informatics.	Usage
CO-5	Able to connect and integrate the knowledge of microbiology and immunology from the perspective of a bioinformatician with special emphasis on microbe-immune interface.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	History and Introduction to Microbial World: Brief history, contributions of important microbiologists, immunologists. Origin of life and the microbial world, different classes of microbes, good and the bad microbes.	3
2	Forms of microorganisms: Prokaryotes: Archaea & Bacteria, Cyanobacteria Eukaryotes: Fungi, Algae, Protozoa Viruses – structure, classification, Viral Replication (Lytic and Lysogenis cycle)	3
3	Morphology and cell structure of microorganisms: Morphological features and characteristics of microorganisms, Gram positive and Gram negative bacteria.	2
4	Methods in microbiology: Pure culture techniques, Principles of microbial nutrition, culture media and types (simple, complex, enriched, enrichment, selective & differential), replica plating techniques	4
5	Growth of microorganisms: Growth curve of microbes, binary fission, enumeration techniques, effect of environmental conditions on growth, extremophiles, preservation techniques	3
6	Microbial Control: Theory and practice of sterilization, Antibiotics and Concept of Resistance, Physical and chemical control methods in practice.	4
7	Genetics and Resistance –Plasmids, Bacterial Conjugation, Transformation, Transduction, and Mutation	4
8	Introduction to Fundamental Concepts in Immunology: Immunology-Specificity, memory, discrimination of self from non-self, Innate and Acquired immunity, Humoral and cell-mediated immune responsePhagocytes and antimicrobial peptide effectors. Cells of the immune system, cytokines, complement system	4

9	Antibody, Antigens and Immune receptors: Immunoglobins: structure and function, immunoglobin classes and functions, monoclonal and polyclonal antibody, types of vaccines, active and passive immunization	4
10	Antigens: Immunogenicity, antigenicity, epitopes-B cell epitopes, T cell epitopes, haptens, Antigen Recognition by immune system: recognition of antigens by T and B Cells: Antigen processing and presentation, MHCs, role of MHC molecules in antigen presentation and co-stimulatory signals.	4
11	Antigen- antibody interactions: Concept, precipitation – double diffusion, radial immunodiffussion, immunoelectrophoresis, agglutination, ABO blood typing.	4
12	Bioinformatics-Immunology and Infectious diseases: Bioinformatics Resources and tools for Human Microbiota and Infectious Agents, Immunoinformatics.	2
13	Failure of Host Defence Mechanisms: Bacterial Persistence and survival strategies, Autoimmunity, Hypersensitivity	1
Total lectures		42

Suggested Text and Reference Book(s):

1. Madigan, M.T., Martinko, J.M., Parker, J: Brock Biology of Microorganisms. 10th Edition.: Publisher: Prentice Hall 2003
2. Prescott, Harley and Klein: Microbiology, 6th Edition, McGraw Hill 2005.
3. Pelczar, Chan and Krieg: Microbiology by; Tata McGraw Hill.
4. Roger Y. Stanier,: General Microbiology
5. R. Ananthanarayan and CK JayaramPaniker: Textbook of Microbiology
6. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology .W.H. Freeman and Co., New York, 7th Ed.
7. Roit, I. (2012). Essential Immunology. Blackwell Scientific Publications, Oxford, 12th Ed.
8. Pathogenomics: Genome analysis of pathogenic microbes by Hacker J and Dorbindt U. ed. Wiley-VCH.

Microbiology and Immune System Lab

COURSE CODE: 14B17BI371

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-1

Pre-requisite: Good Laboratory Practices

Course Objectives:

4. The objective of this course is to demonstrate basic microbiological and immunological principles, approaches that enable study of microbe-host immune- interface and enable students to translate the theoretical foundation in the subject into practical understanding.
5. Techniques and methods to study different classes of microbes, immune system related molecules will be performed.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Students will be able to understand and apply basic microbiological techniques and correlate them with their fundamental concepts in the subject.	Introductory
CO2	Students will be able to understand and apply basic immunological techniques and correlate them with their fundamental concepts in the subject.	Introductory
CO3	At the end of the course, students are expected to gain a broad appreciation of the basic methods and their application in the field of microbiology, handle microbial cultures independently, to study applied aspects of microbiology.	Technical
CO4	At the end of the course, students are expected to gain a broad appreciation of the basic methods and their application in the field of immunology along with applied aspects of immunology.	Technical
CO5	At the end of the course, students are expected to gain a broad	Usage

	appreciation of the basic methods and their application in the field of microbiology and immunology along with handle microbial cultures independently, to study applied aspects of microbiology.	

List of Experiments

S.No	Description	Hours
1.	Culture Techniques for Microorganisms: General microbiology procedures and Equipments - use and Safety Considerations, GLP. a. Preparation of culture media for different classes of microbes (bacteria and fungi) b. Bacterial growth curve: Spectrophotometry c. Culture and Isolation of microorganisms – soil, air, water d. Quantification, Purification of microorganisms	10
2.	Microscopy and Staining: Handling, microscopic examination of different classes of microorganisms: Bacteria, fungi a. Simple and differential staining of different shapes and sizes of bacteria – *acid fast, gram staining* b. Microscopic examination of specific fungi using Lactophenol cotton blue staining	4
3.	Identification/Characterization Techniques for Microorganisms: a. Preservation techniques b. Biochemical characterization c. Antimicrobial Susceptibility (Disk-diffusion) Test	6
4.	Antigen – Antibody Interactions: a. Double diffusion b. Radial Immunodiffusion c. Rocket Immunoelectrophoresis d. ABO Blood typing	8

Total Lab hours	28

Suggested/Resources:

1. Benson, Harold J: Microbiological Applications : Laboratory Manual in General Microbiology, McGraw-Hill Higher Education, 2007.
2. Cappuccino, James G.: Microbiology: A Laboratory Manual, Pearson Education Sherman, Natalie Asia, 2004.
3. Harley, John P.: Laboratory Exercises in Microbiology, Tata McGraw Hill, 2003.
4. Dubey, R.C., Maheshwari, D.K.: Practical microbiology, S. Chand and Company Ltd, New Delhi, 2003.

Evaluation Scheme:

Linux Lab

COURSE CODE: 14B17BI372

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

To Understand and master Linux and UNIX based OS environment and understanding to various Linux flavors.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand Unix environment	Familiarity
CO2	Familiarize with Unix and Linux commands.	Familiarity
CO3	To learn and master Bash and Shell scripting	Usage
CO4	To learn automating script-based job scheduling in Unix	Usage
CO5	To learn and master administrating and managing superuser-based managing accounts.	Usage

List of Experiments

S.No	Description	Hours
1	Introduction to Unix and Shell	2
2	Installing Fedora	2
3	Unix directories and pathnames and Rules for entering unix commands	2
4	Configuring your Linux environment	2
5	Working with Hard drives, Listing and Finding Directories and Files	2
6	Manipulating Files in Unix	2

7	Comparing, Sorting, Modifying, Combining, and Splitting Files, Searching for Lines in a File or Pipeline	2
8	Replacing or Removing Text From a File or Pipeline	2
9	Using vi to Edit a Text File and Command-Line Editing in the Korn Shell	2
10	Writing Bourne Shell Scripts and awk scripts	2
11	Additional commands	2
12	Network commands	2
Total Lab hours		**24**

Suggested/Resources:

1. **Practical Linux**, Drew Streib et al Que, Indianapolis, 2000
2. **Practical Unix**, Steve Moritsugu et al, Que, Indianapolis, 2000
3. **Linux: a practical approach** , B. Mohamed Ibrahim 2006

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

4th sem

Genetic Engineering and Genomics

COURSE CODE: 15B11BI411

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: Molecular Genetics

Course Objectives:

6. Familiarize the students with the basic concepts in genetic engineering
7. Acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology
8. To make the students familiar with basic concepts of technologies.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will become aware of concept of genetic engineering and genomics and its applications	Familiarity and Basics
CO-2	Students will have knowledge of tools and strategies used in genetic engineering	Technical and strategies
CO-3	Student will acquire knowledge about gene libraries and isolation of genes	Technical and application
CO-4	Student will develop understanding of DNA and genome sequencing technologies	Technical and strategies
CO-5	Student will be able to explore domains of genomic technologies	Application

Course Contents:

Unit	Contents	Lectures required
	Module I Genetic Engineering	
1	**Introduction:** Genetic engineering, Recombinant DNA technology: gene cloning - concept and basic steps - rDNA Glossary, Genomics Concept scope and applications	3
2	**DNA modifying enzymes and cloning techniques:** Restriction Endonucleases, DNA Ligation Enzymes and, DNA, Gene cloning methods and strategies: Cloning of PCR products, TA cloning, DNA Modifying Enzymes: Nucleases, Kinases, phosphatases, Reverse transcriptase	6
3	**Cloning and Expression Vectors:** Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Vectors for Cloning Large DNA Molecules, Expression Vectors	6
4	**Construction & Screening of genomic libraries:** Genomic library, cDNA library, Growing & Storing Libraries, cDNA Cloning (5'&3' RACE)	4
5	**Gene transfer Methods**: Gene Transfer methods plants and animal cells, Transgenic plants and animals and their applications	4
	Module II Genomics	
6	**Structural genomics:** Genome Analysis, Genomics: Organization and structure of Genomes, genome complexity Sequencing genes and short stretches of DNA: Basic DNA Sequencing, Next generation sequencing technologies	7
7	**Mapping and sequencing genomes**: Introduction, Molecular Markers Genetic and Physical Mapping of Genomes, *Sequencing of whole genomes,* Sequence analysis of genomic DNA for identification of genes and other features data and molecular phylogenetics	6
8	**Functional Genomics:** RNA expression analysis Comparative genomics	4
9	**Application domains of genome technologies**: Genomics and Medicine, Genomics and Agriculture	2

Total lectures	42

Suggested Text Book(s):

7. Principles of Gene Manipulation and Genomics SEVENTH EDITION S.B. Primrose and R.M. Twyman.
8. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz.
9. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College ; With Foreword by Francis S. Collins

Suggested Reference Book(s):

1. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz
2. Molecular Biotechnology: Principles & Applications of Recombinant DNA Glick BR and Pasternak JJ
3. Genetic Engineering : Amita Rastogi and Neelam Pathak

Genetic Engineering and Genomics Lab

COURSE CODE: 15B11BI471

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

The objective of the course is to give practical exposure to student about basic tools and techniques employed in recombinant DNA technology and genomics.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Students will be able to isolate and analyze plasmid vectors.	Technical
CO2	Students will be cut and ligate DNA fragments/vectors with help of restriction enzymes and ligase.	Technical
CO3	The students will be able to prepare competent cells	Technical
CO4	The students will be able demonstrate bacterial transformation with given vectors	Technical
CO5	Students will be able to perform genome annotations, gene and molecular marker prediction	Technical

List of Experiments

S.No	Description	Hours
Lab-I	Introduction to rDNA laboratory, w.r.t. working bench, types of instruments and their handling, lab. Preparation of stock solutions of buffers for use in gel running, gel loading, their autoclaving; preparation of working buffers, antibiotic stocks, and storage of buffers required in rDNA practicals with detailed methodology	4

Lab 2-3	Plasmid DNA Preparation: Preparation of LB medium with and without antibiotics for the growth of bacterial cultures, Growth of *E. coli*, Isolation of Plasmid DNA, Electrtrophoresis of Plasmid DNA and Interpretation of results	4
Lab 4	Restriction of given plasmid or λ DNA with the restriction enzyme *Eco*RI and HindIII or any other Restriction Enzymes	4
Lab 4 -5	To perform ligation of λ/*Eco*R I digest using T4 DNA Ligase Electrophoresis of the uncut and digested DNA and Interpretation of the results Electrophoresis of ligated samples by agarose gel electrophoresis, Interpretation of the results	4
Lab 6	Preparation of competent cells of *E. coli* transformation	4
Lab 8	Transformation of E.coli. DH5 α cells with Empty puc/ pcambia1301/and Confirmation of transformed cells by scoring the expression of LacZ gene.	4
Lab 9	DNASTAR MODULES	4
Lab 10	PRIMER Designing	4
Lab 11	Unknown Gene Prediction Tools and Packages	4
Lab 12	Molecular Markers Prediction (SSR and SNP)	4
Lab 13	Overview of Genomic Resources: Data retrieval and analysis	4
Lab 14	Tools for expression data analysis	4
Total Lab hours		

Suggested/Resources:

4. Lab Mannual.

5. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College ; With Foreword by Francis S. Collins

6. Virtual Lab

Programming Languages for Bioinformatics

COURSE CODE: 15B11BI421

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

To familiarize and master the programming skills in Perl and Python.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Write and execute a script in Perl.	Usage
CO-2	Enable routine and module calls and their implementation using Bioperl.	Familiarity
CO-3	Able to formulate stepwise implementation of a Perl script (from developing a pseudo-code to execute a successful bug-free code) for a given problem in Bioinformatics	Usage
CO-4	Write and execute a script in Python	Usage
CO-5	Enable routine and module calls and their implementation using Biopython.	Familiarity
CO-6	Able to formulate stepwise implementation of a Python script (from developing a pseudo-code to execute a successful bug-free code) for a given problem in Bioinformatics	Usage

Course Contents:

Unit	Contents	Lectures required
1	Crash course in C	2
2	Programming basics	1
3	Sequences and Strings: Storing a DNA sequence, Concatenation, Transcription, Translation	2
4	Arrays and Scalar list, Strings to Array, Operations on Strings	2
5	Subroutines and Command line arguments	3
6	Modules, Calling modules	2
7	Hashes, Data Structures in Perl	4
8	Reading files and writing output formats	3
9	Regular expressions and Perl Operations	3
10	Parsing genbank, PDB, BLAST, and other file formats	3
11	Object-oriented programming, Complex Data Structures, Relational Databases	4
12	BioPerl	3
13	Introduction to Python	3
14	BioPython	4
15	Applications of Python and BioPython	3
Total lectures		42

Suggested Text Book(s):

1. Beginning Perl for Bioinformatics By James Tisdall, O'Reilly Media (2001)
2. Mastering Perl for Bioinformatics By James Tisdall, O'Reilly Media (2003)
3. Python For Bioinformatics By Sebastian Bassi, Chapman and Hall (2010)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination

1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

Programming Languages for Bioinformatics Lab

COURSE CODE: 15B11BI472

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: C, Object-oriented data structures.

Course Objectives:

To master programming skills in Perl and Python and implement those skills using BioPerl and BioPython.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Write and execute a script in Perl.	Usage
CO2	Enable routine and module calls and their implementation using Bioperl.	Familiarity
CO3	Able to formulate stepwise implementation of a Perl script (from developing a pseudo-code to execute a successful bug-free code) for a given problem in Bioinformatics	Usage
CO4	Write and execute a script in Python	Usage
CO5	Enable routine and module calls and their implementation using Biopython.	Familiarity
CO6	Able to formulate stepwise implementation of a Python script (from developing a pseudo-code to execute a successful bug-free code) for a given problem in Bioinformatics	Usage

List of Experiments:

S.No	Description	Hours
1	Installing and learning how to run Perl, Good programming practices	2
2	File Handling	2
3	Understanding Sequences and Strings, Operation on Strings - Motif finding	2
4	Writing a subroutine and calling, Translation of DNA to Protein Sequences	2
5	Mutating a DNA sequence and generating a random DNA sequence	2
6	Reading from various file formats	2
7	Installing Bioperl, Translation of DNA to Protein Sequences using Bioperl	2
8	Reading and Parsing PDB files using Bioperl	2
9	Automating BLAST and Parsing BLAST Output using Bioperl	2
10	Python File handling	2
11	Gene Expression Analysis with Python	2
12	Using BioPython – Part I	2
13	Using BioPython – Part II	2
Total Lab hours		26

Suggested/Resources:

1. Pauline M. Doran, “Bioprocess Engineering Principles” 8th ed., Academic press, New York, 2003.
2. M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
3. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).

5th Sem

Structural Bioinformatics

(15B11BI511)

Credits: 4(L 3 T 1)

Introduction:

Structural Bioinformatics course is designed to connect with the lab course "Structural Bioinformatics Lab" and the preceding course in IInd Semester "Structural Biology". With the fundamental knowledge acquired about protein structures in "Structural Biology" and "Structural Bioinformatics" theory courses, here the students will be developing skills to predict protein structures, understanding the various secondary and tertiary databases on protein structures and able to analyze the function of a protein from its structure.

Course Objective:

- Able to predict, analyze, and compare structures of proteins and associate with its function.
- Able to understand computational tools of Structural Biology/Bioinformatics and simulate their dynamical behaviour.

Learning Outcome:

CO I: Protein Structure comparing algorithms and protein structure classification algorithms. CO II: Predicting Secondary structure and Tertiary structure of proteins and assessing their quality.

CO III: Protein sequence- and structure-based functional site prediction.

CO IV: Protein dynamics (fine-grained and coarse-grained) methods and predicting protein function.

Topics covered and number of lectures mapped to COs:

Topic	Lectures	Learning Outcomes
Module I: Introduction		
Revisiting Structural Biology (IInd Semester), PDB and PDB format	2	CO I

Internal and External Coordinates		
Evolution of protein folds	2	CO I
Classification of Protein Structures	3	CO I
Computational aspects of High-throughput crystallographic macromolecular structure determination	2	CO I
Module II: Comparison and Prediction of Structures		
Structure comparison and Alignment	4	CO I
Prediction of secondary structure of protein sequences (Chou-Fasman, GOR and Neural Networks)	4	CO II
Prediction of tertiary structures of protein sequences (Homology and Threading methods); structure quality assessment	4	CO II

Fold recognition methods; Assessment of Protein structure prediction (CASP, CAFASP)	2	CO II
Module III:Structural and Functional Assignment		
Structural domains in protein	2	CO III
Inferring Protein function from Structure (Characterizing enzyme binding sites)	2	CO III
Module IV: Protein Interactions		
Prediction of protein-protein interactions from evolutionary information	2	CO III
Protein Electrostatics	1	CO III
Module V: De novo prediction and Simulation		
Ab initio protein structure prediction: Empirical force field for biomolecular simulations, Potential Energy Function (bond length potential, bond angle potential, torsional potential, van der Waals potential and coulomb potential), classical representations of electrostatics (Poisson-Boltzmann, Generalized Born and Colombic).	3	CO IV
Energy minimization techniques: concept of local and global minima, energy minimization protocol, energy minimization algorithms (steepest descent, conjugate gradient, Newton Raphson)	3	CO IV
Molecular Dynamics Simulation methods, Monte Carlo Simulations, Techniques for efficient conformational search: Simulated Annealing, Calculation of Free energy using simulation techniques.	3	CO IV
Elastic network Models	1	CO IV
Module VI: Future and New Trends		
Structural Genomics	1	CO IV
Computational Protein Design	1	CO IV

Teaching Methodology:

The course will be taught through lectures, tutorials. Specifically, the following will be implemented throughout the course.

- Lectures in class that have interactive learning that initiate students to query and probe further.

- Assignments that involve reading topics that were discussed in the class, which enable the students to discover knowledge beyond the classroom.

- Project based learning that enable the students to formulate hypothesis and good scientific practices.

- Tutorials will have a hands-on approach to write scripts and enable an active learning approach

- Study materials, apart from textbooks, will be videos, articles, and other resources that can augment the learning process.

- Periodic review of performance using quizzes, assignments, and oral questions whose feedback will enable students to identify lacunae in their knowledge.

Evaluation Schemes:

The assessment and evaluation of Learning objectives and course outcomes will be done throughout the course, periodically. It will be implemented as follows:

- Surprise quizzes will enable them to regurgitate the previous week's lessons and topics. Weekly assignments with supplementary reading materials (pdfs and videos) will assess if the student was able to understand the applications and the overall big picture, as to why they have to study a particular topic.

- One on one counseling and assessment will be performed periodically to familiarize the student's strength and weaknesses.

- T1 and T2 question paper will assess if the relevant COs for the particular modules have been achieved or not. If not, then remedial measures will be carried out to rectify and bring every student at the expected levels.

Examinations	Marks (%)	Duration (hrs)
First Term (T-I)	15	1:00
Mid Term Test (T-II)	25	1:30
End Term Test (T-III)	35	2:00
Internal Assessment (Based on assignments, quizzes, research paper reading and group discussion, case studies, etc.) Attendance: 5 Participation in group discussions in lectures/tutorials: 10 Assignment/ Case Studies: 10	25	Entire Semester
Total	100	

Text Books:

1. Structural Bioinformatics by Philip E. Bourne and Helge Weissig, Wiley-Liss (2003)
2. Computational Structural Biology by Torsten Schwede and Manuel Peitsch, World Scientific (2008)
3. Understanding Molecular Simulation by Daan Frenkel and Berend Smit, Academic Press (2002)
4. Molecular Modeling: Principles & Applications, Andrew R. Leach, Prentice Hall (2001)

Structural Bioinformatics Lab

COURSE CODE: 15B17BI571

COURSE CREDITS: 1 CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Structural Biology

Course Objectives:

To develop the ability to design, predict, analyze and compare the protein structures as well as predict the function of target proteins.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understanding the fundamental concepts of structural biology (chemical building blocks, structure, superstructure, folding, etc.)	Familiarity
CO2	To Understand and use structural databases and software for structure visualization	Familiarity
CO3	To understand the algorithms used in Structure determination and quality assessment	Assessment
CO4	To perform protein structure comparison and the hierarchical nature of biomacromolecular structure classification	Usage
CO5	To understand the methodology of protein structure prediction and assessment	Assessment
CO6	To understand the methodology of sequence- and	Assessment

	structure-based functional site prediction	

List of Experiments:

S.No	Description	Hours
1	Homology modeling using Swiss-Modeller and Modeler standalone software	2
2	Searching and analyzing SCOP and CATH database; analysis of protein structure (protein ligand and protein-protein complexes) using pdbsum, ligplot and dimplot	2
3	Prediction protein secondary structure using above methods and comparison, calculating Q3 value and SOV score.	2
4	Prediction of tertiary structure of protein sequences (using Modeller and GenThreader)	2
5	Error estimation and precison of predicted protein structures (Procheck, What IF, Errat, Verify3D, etc.)	2
6	Comparing protein structures (using CE, DALI, Comparer, SARF2, SSAP, VAST) and statistical analysis of results	2
7	Secondary structure assignment of protein structure using DSSP, STRIDE, DEFINE and P-Curve and statistical analysis of results	2

8	Predicting structural domains (using PRODOM) and binding sites (acSite, SiteMatch, SiteFinder, etc.)	2
9	Ab initio prediction of various energy components of protein structure and validation of structure	2
10	Prediction of PBSA and GBSA energy components using molecular simulation technique	2
11	Filling of gaps in protein structure, energy minization and validation of protein structure	2
12	Setting of MD simulation job of protein structure, interpretation of results and refinement of structure.	2
Total Lab hours		24

Suggested/Resources:

Structural Bioinformatics (2nd Edition), Jenny Gu (Editor), Philip E. Bourne (Editor)

1. **.W. Mount Bioinformatics: Genome and Sequence Analysis: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.**
2. **Molecular Modeling: Principles & Applications, Andrew R. Leach, Prentice Hall**

Computational Genomics

15B11BI512 Core Course

Credits: 4

L 3 T 1 P 0

Pre-requisites: Basics of genetics and genomics, and basic methods in bioinformatics

Course Objectives (Learning Goal):

1. The overall objective of the course is to learn computational methods and approaches available for biological data analysis.
2. Develop skills to perform computational analysis and to develop new methodologies for genomics.

Course Assessment:

Exam	% of Marks	Duration	Coverage / scope
TEST-1	15 %	1 Hour	Syllabus covered up to Test-1
TEST-2	25 %	1.5 Hour	Syllabus covered up to Test-2
Makeup Test	25 %	1.5 Hour	Syllabus covered up to Test-2
TEST-3 (Final Exam)	35 %	2 Hour	Entire semester
Internal Assessment and Attendance	25 %	Entire Semester	Entire semester

Course Outcomes:

CO I: An understanding of the basic of genomics, principles, method, instrumentation, computational techniques and current aspects of modern functional genomics.

CO II: Understanding of computational techniques of data annotation, learning and development of tools for the analyses of genomic and proteomic data.

CO III: Acquaintance to solve the computation-related problems which demonstrate an understanding of the basic principles of modern genomics and to understand the biological complexity and capability enhancement to resolve the recent genomic problems.

Topics covered:

Topic	Lec. Hours	Lab Mapping
Fundamentals of Computational genomics: Genomes - diversity, size, structure and information content. Human genome project, Digitalization of biological data, Computational aspects of large scale genome sequencing strategies.	12	1-2
Genome fragmentation, assembly and annotation. Next gen sequencing: methods and applications, Computational strategies of mappings and analysis. Physical maps, restriction maps, linkage maps etc. Codon usage analysis, Haplotyping, Pedigree information and analysis. Polymorphism and recombination strategies. Statistical mechanics approaches and their applications in biological feature identification and selection.	8	3-5
Comparative and functional genomics: Predictions of promoters, genes, splice sites, regulatory regions, genome assembly, overlap and repeat finding, transcription binding factors and Sites and gene expression studies. Genome and gene order comparisons, Comparative genomics databases: COG, and VOG. Gene functions, and pattern identification through sequence and structure based approaches.	12	6-7
Genomic and Proteomic databases, tools and servers: Plants, animals and specialized genomic resources, GSS, MeSH, OMIM, Gene Expression Omnibus (GEO) HomoloGene, UniGene, UniSTS and Probe database, Array Express, SAGE, Popset analysis, SNP and EST database, Genotypic and phenotypic databases, Genomic structural variation database, Genomic taxonomy, and other databases, tools, and servers related to genome analysis. Microarrays and Gene expression: Introduction to microarray data, probabilistic modeling of array data and clustering algorithms for gene regulation.	8	8-11

Computational standards for Genomics: Genome analysis through various statistical and probabilistic techniques. Universal approximation properties, Data processing and interpretation, prediction performance and evaluation. Probabilistic Models of Evolution: Models of evolution,	5	12-14
substitution probabilities and evolutionary rates, rates of evolution, data likelihood and optimal trees. Implementation of classification techniques for gene expression and proteomic data. Functional annotations at genomic, proteomic and pathway levels.		
Total	**45**	

Text and Reference Books:

1. Dan E. Krane and Michael L. Raymer, 'Fundamental concepts of Bioinformatics', Pearson Education (low Priced Edition).
2. Claverie & Notredame, 'Bioinformatics - A Beginners Guide', Wiley- Dreamtech India Pvt Ltd, 2003.
3. J. Pevnezer, 'Bioinformatics and functional genomics', John Wiley.
4. Bioinformatics: sequence and Genome Analysis, by David Mount, second Edition.Cold Spring harbour labortory press(2004).
5. Discovering Genomics, Proteomics and bioinformatics, 2/E by A.Malcolm Campbell and Laurie J.Heyer,Publisher:Benjamin Cummings(2007)
6. ICRF handbook of genome analysis, by NK Spurr, BD Young, SP Bryant. Volumes I &

II. - Blackwell science publishers.

7. Isaac S. Kohane, Alvin T. Kho, Atul J. Butte Microarrays for an Integrative Genomics 2003 MIT Press.

Computational Genomics Lab

(15B17BT671)

Credit: 0-0-2=1

Pre-requisites: Basics of molecular biology concepts, genetics and genomics concepts, and basic knowledge of Programming in Perl or any other programming language.

Course Objectives (Learning Goal):

1. To determine the function of genes and the elements that regulate genes throughout the genome.
2. To apply genome-based strategies for the early detection, diagnosis, and treatment of disease.
3. To explore how DNA material interact with one another and with Protein environment to create complex living systems.
4. To make students enable to connect theoretical concepts of Genomes to their programmatic implementations and to better understand the concept of genome.

Course Assessment:

Exam / Activity	% of Marks	Duration	Coverage / scope
Day to day work (i) Attendance (ii) Quantity & Quality of Experiments including Performed, Learning laboratory Skills and handling Laboratory Equipment, Instruments, Gadgets, Components, Materials and Software etc. (iii) Laboratory record	60 % (15%) (30%)	Entire Semester	Entire semester

	(15%)		
Mid Semester lab-viva/test	20 %	2 Hour	Syllabus covered up to mid semester
End Semester lab-viva/test	**20 %**	**2 Hour**	**Entire semester**

Course Outcomes:

CO I: Able to apply various Bioinformatics and System biology Software and tools to understand genetics/genomics of living things.

CO II: Use various programming techniques and languages to implement algorithmic methods from computational biology to describe and analyze problems in biology.

Topic Covered:

S. No.	Name of Experiments	No. of Hours

1	Explore and learn Online tools like ORF finder, Genomatrix, Pasteur.fr, Gene Evaluator, Gene Translator Make program in Perl to read Fasta file of nucleotide and protein sequences and display it on screen.	2
2	Basic concepts and applications BLAST2, MegaBlast algorithms, PipMaker, AVI Vista, MUMmer, Genotation	2
3	Develop concepts for restriction mapping using different tools	2
4	Primer designing principles and PCR, e-PCR etc.	2
5	Computational analysis of microarray data (DNA microarray: database and basic tools, Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases).	2
6	Methods and applications of inbuilt tools for Next generation sequencing Data. (illumina and advaita resource).	2
7	Proteomics analysis tools	2

8	Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps, gene expression profiling.	2
9	Gene/Protein function prediction using Machine learning tools viz. Neural network, SVM etc.	2
10	Biomarker discovery through various computational approaches for myriad of diseases	2
11	Large scale genome sequencing strategies , Genome assembly and annotation , Genome databases of Plants, animals and pathogens, Metagenomics	2
12	Write Program in Perl to annotate genomic sequences wrt various parameters	2
13	Genetic pathway reconstruction using pathway tool and their annotation through system biology	2
14	Write Program in Perl to annotate proteomics sequences wrt various parameters	2

Text and Reference Books:

1. Dan E. Krane and Michael L. Raymer, 'Fundamental concepts of Bioinformatics', Pearson Education (low Priced Edition).
2. Claverie & Notredame, 'Bioinformatics - A Beginners Guide', Wiley- Dreamtech India Pvt Ltd, 2003.
3. K Mani & N Vijayaraj, 'Bioinformatics: A practical approach', Aparna Publications, Coimbatore.
4. Setubal & Meidanis, 'Introduction to Computational Molecular Biology', Thomson: Brooks/Cole, International Student Edition, 2003.
5. J. Pevnezer, 'Bioinformatics and functional genomics', John Wiley.
6. Bioinformatics: sequence and Genome Analysis, by David Mount, second Edition.Cold Spring harbour labortory press(2004).
7. Discovering Genomics, Proteomics and bioinformatics,2/E by A.Malcolm Campbell and Laurie J.Heyer,Publisher:Benjamin Cummings(2007)

8. ICRF handbook of genome analysis, by NK Spurr, BD Young, SP Bryant. Volumes I & II. - Blackwell science publishers.

9. Isaac S. Kohane, Alvin T. Kho, Atul J. Butte Microarrays for an Integrative Genomics 2003 MIT Press.

Scripting Languages for Bioinformatics

(10B11BI512)

Credit: 3-1-0=4

Objective:

To apply, and develop scripting languages codes and implement them towards the analysis of biological data. Additionally to Develop web based applications for the problems in biology.

Topic	Lec. Hours	Lab Mapping
An overview of scripting languages, with applications towards biological sequence data analysis. Complexity of DNA problems and their computational implications and applications. Introduction to HTML, DHTML, XML. accessing different objects of the HTML page, Dynamic page generation.	12	1-4
JAVASCRIPT: Document object model, Elements of the document object model, programming using JavaScript; XML: DTD, xmlschemas, xml document structure, retrieving data from database in xml format; various bio based versions of XML.	8	5-8
PHP: PHP beginning to advanced level, mathematical expressions and functions in PHP, PHP programming (implementation of object model), Database connectivity using PHP.	12	9-12
Perl CGI: Programming in Perl, basic functions in Perl, pattern matching using Perl and their biological applications, object oriented concepts in Perl, GUI development in Perl, web programming using CGI interface.	8	13
Emphasis in this subject will be on hands-on practice on above languages. It will include programming skillls to be applied for solving problems in biology. Development of bioinformatic based small applications and web based applications.	5	13
Total	45	

Methodology:

The course will be taught through lectures, tutorials, and assignments.

Evaluation Schemes:

Exam	% of Marks	Duration	Coverage / scope
TEST-1	15 %	1 Hour	Syllabus covered up to Test-1
TEST-2	25 %	1.5 Hour	Syllabus covered up to Test-2
Makeup Test	25 %	1.5 Hour	Syllabus covered up to Test-2
TEST-3 (Final Exam)	35 %	2 Hour	Entire semester
Internal Assessment and Attendance	25 %	Entire Semester	Entire semester

Outcome: Students will be able to develop their own and interactive websites. These will help in developing applications for solving problems in biology, and development of web based resources etc. Their concepts for web development, client side and server side programming will also be developed at professional level.

Text and Reference Books:

1. HTML the complete reference, 2004, TMH.

2. Beginning PHP and Professional PHP, 2009, Wrox, Wiley Dreamtech.

3. JavaScript: The complete Reference, 2004, TMH.

4. Biological Sequence Analysis: Probabistic models of proteins and nucleic acids (1998) Durbin R., et al, Cambridge University press.

5. Beginning Perl for Bioinformatics, Tisdall J.D., O'Reilly.

Scripting Languages Lab for Bioinformatics

(10B11BI572)

Credit: 0-0-1=1

Objective:

To apply, and develop scripting languages codes and implement them towards the analysis of biological data. Additionally to develop web based applications.

S. No.	Topic	Lec. Hours
1	Introduction to HTML, DHTML, XML and accessing different objects of the HTML page and dynamic page generation.	1
2	HTML code for basic understanding of the syntax including the use of nesting of lists.	1
3	HTML code for creating a webpage including hyperlinks and images.	1
4	Construction of DTD schema ,a sample xml document to represent evolutionary tree	1
5	Construction of XML schema, a sample xml document to represent a pathway	1
6	Implementation of Session, request, report objects in an ASP application	1
7	Create a MySql/ MSacesses database tables and execute all SQL queries	1
8	Development of an PHP program to take set of sequences and find out conserved sequences	1
9	Write a PHP program to construct a pathway	1
10	Write a PHP program to connect mysql database and execute all SQL commands	2
11	Construct a PHP interface for a given ER model	1

12	Perl program to find out ORFs existing in a given genomic sequence	1
13	Perl program to find out annotation and sequence from a fasta file	1
	Total	14

Methodology:

The course will be taught through assignments, and practical demonstrations.

Evaluation Schemes:

Exam / Activity	% of Marks	Duration	Coverage / scope
Day to day work (i) Attendance (ii) Quantity & Quality of Experiments including Performed, Learning laboratory Skills and handling Laboratory Equipment, Instruments, Gadgets, Components, Materials and Software etc. (iii) Laboratory record	60 % (15%) (30%) (15%)	Entire Semester	Entire semester
Mid Semester lab-viva/test	20 %	2 Hour	Syllabus covered up to mid semester
End Semester lab-viva/test	20 %	2 Hour	Entire semester

Outcome: Students will be able to develop their own and interactive websites. These will help in developing applications for solving problems in biology, and development of web based resources etc.

Books:

1. HTML the complete reference, 2004, TMH.

2. Beginning PHP and Professional PHP, 2009, Wrox, Wiley Dreamtech.

3. JavaScript: The complete Reference, 2004, TMH.

4. Biological Sequence Analysis: Probabistic models of proteins and nucleic acids (1998) Durbin R., et al, Cambridge University press.

Structural Bioinformatics (15B11BI511)

JUIT, Waknaghat Credits: 4(L 3 T 1)

Introduction:

Structural Bioinformatics course is designed to connect with the lab course "Structural Bioinformatics Lab" and the preceding course in IInd Semester "Structural Biology". With the fundamental knowledge acquired about protein structures in "Structural Biology" and "Structural Bioinformatics" theory courses, here the students will be developing skills to predict protein structures, understanding the various secondary and tertiary databases on protein structures and able to analyze the function of a protein from its structure.

Course Objective:

- Able to predict, analyze, and compare structures of proteins and associate with its function.
- Able to understand computational tools of Structural Biology/Bioinformatics and simulate their dynamical behaviour.

Learning Outcome:

CO I: Protein Structure comparing algorithms and protein structure classification algorithms. CO II: Predicting Secondary structure and Tertiary structure of proteins and assessing their quality.

CO III: Protein sequence- and structure-based functional site prediction.

CO IV: Protein dynamics (fine-grained and coarse-grained) methods and predicting protein function.

Topics covered and number of lectures mapped to COs:

Topic	Lectures	Learning Outcomes
Module I: Introduction		
Revisiting Structural Biology (IInd Semester), PDB and PDB format Internal and External Coordinates	2	CO I
Evolution of protein folds	2	CO I
Classification of Protein Structures	3	CO I
Computational aspects of High-throughput crystallographic	2	CO I

macromolecular structure determination		
Module II: Comparison and Prediction of Structures		
Structure comparison and Alignment	4	CO I
Prediction of secondary structure of protein sequences (Chou-Fasman, GOR and Neural Networks)	4	CO II
Prediction of tertiary structures of protein sequences (Homology and Threading methods); structure quality assessment	4	CO II

Fold recognition methods; Assessment of Protein structure prediction (CASP, CAFASP)	2	CO II
Module III:Structural and Functional Assignment		
Structural domains in protein	2	CO III
Inferring Protein function from Structure (Characterizing enzyme binding sites)	2	CO III
Module IV: Protein Interactions		
Prediction of protein-protein interactions from evolutionary information	2	CO III
Protein Electrostatics	1	CO III
Module V: De novo prediction and Simulation		
Ab initio protein structure prediction: Empirical force field for biomolecular simulations, Potential Energy Function (bond length potential, bond angle potential, torsional potential, van der Waals potential and coulomb potential), classical representations of electrostatics (Poisson-Boltzmann, Generalized Born and Colombic).	3	CO IV
Energy minimization techniques: concept of local and global minima, energy minimization protocol, energy minimization algorithms (steepest descent, conjugate gradient, Newton Raphson)	3	CO IV
Molecular Dynamics Simulation methods, Monte Carlo Simulations, Techniques for efficient conformational search: Simulated Annealing, Calculation of Free energy using simulation techniques.	3	CO IV
Elastic network Models	1	CO IV
Module VI: Future and New Trends		
Structural Genomics	1	CO IV
Computational Protein Design	1	CO IV

Teaching Methodology:

The course will be taught through lectures, tutorials. Specifically, the following will be implemented throughout the course.

- Lectures in class that have interactive learning that initiate students to query and probe further.

- Assignments that involve reading topics that were discussed in the class, which enable the students to discover knowledge beyond the classroom.

- Project based learning that enable the students to formulate hypothesis and good scientific practices.

- Tutorials will have a hands-on approach to write scripts and enable an active learning approach

- Study materials, apart from textbooks, will be videos, articles, and other resources that can augment the learning process.

- Periodic review of performance using quizzes, assignments, and oral questions whose feedback will enable students to identify lacunae in their knowledge.

Evaluation Schemes:

The assessment and evaluation of Learning objectives and course outcomes will be done throughout the course, periodically. It will be implemented as follows:

Surprise quizzes will enable them to regurgitate the previous week's lessons and topics. Weekly assignments with supplementary reading materials (pdfs and videos) will assess if the student was able to understand the applications and the overall big picture, as to why they have to study a particular topic.

- One on one counseling and assessment will be performed periodically to familiarize the student's strength and weaknesses.

- T1 and T2 question paper will assess if the relevant COs for the particular modules have been achieved or not. If not, then remedial measures will be carried out to rectify and bring every student at the expected levels.

Examinations	Marks (%)	Duration (hrs)
First Term (T-I)	15	1:00
Mid Term Test (T-II)	25	1:30
End Term Test (T-III)	35	2:00
Internal Assessment (Based on assignments, quizzes, research paper reading and group discussion, case studies, etc.) Attendance: 5 Participation in group discussions in lectures/tutorials: 10 Assignment/ Case Studies: 10	25	Entire Semester
Total	100	

Text Books:

1. Structural Bioinformatics by Philip E. Bourne and Helge Weissig, Wiley-Liss (2003)
2. Computational Structural Biology by Torsten Schwede and Manuel Peitsch, World Scientific (2008)
3. Understanding Molecular Simulation by Daan Frenkel and Berend Smit, Academic Press (2002)
4. Molecular Modeling: Principles & Applications, Andrew R. Leach, Prentice Hall (2001)

Structural Bioinformatics Lab

COURSE CODE: 15B17BI571

COURSE CREDITS: 1 CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Structural Biology

Course Objectives:

To develop the ability to design, predict, analyze and compare the protein structures as well as predict the function of target proteins.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understanding the fundamental concepts of structural biology (chemical building blocks, structure, superstructure, folding, etc.)	Familiarity
CO2	To Understand and use structural databases and software for structure visualization	Familiarity
CO3	To understand the algorithms used in Structure determination and quality assessment	Assessment
CO4	To perform protein structure comparison and the hierarchical nature of biomacromolecular structure classification	Usage

CO5	To understand the methodology of protein structure prediction and assessment	Assessment
CO6	To understand the methodology of sequence- and structure-based functional site prediction	Assessment

List of Experiments:

S.No	Description	Hours
1	Homology modeling using Swiss-Modeller and Modeler standalone software	2
2	Searching and analyzing SCOP and CATH database; analysis of protein structure (protein ligand and protein-protein complexes) using pdbsum, ligplot and dimplot	2
3	Prediction protein secondary structure using above methods and comparison, calculating Q3 value and SOV score.	2

4	Prediction of tertiary structure of protein sequences (using Modeller and GenThreader)	2
5	Error estimation and precison of predicted protein structures (Procheck, What IF, Errat, Verify3D, etc.)	2
6	Comparing protein structures (using CE, DALI, Comparer, SARF2, SSAP, VAST) and statistical analysis of results	2
7	Secondary structure assignment of protein structure using DSSP, STRIDE, DEFINE and P-Curve and statistical analysis of results	2
8	Predicting structural domains (using PRODOM) and binding sites (acSite, SiteMatch, SiteFinder, etc.)	2
9	Ab initio prediction of various energy components of protein structure and validation of structure	2
10	Prediction of PBSA and GBSA energy components using molecular simulation technique	2
11	Filling of gaps in protein structure, energy minization and validation of protein structure	2
12	Setting of MD simulation job of protein structure, interpretation of results and refinement of structure.	2
Total Lab hours		24

Suggested/Resources:

1. Structural Bioinformatics (2nd Edition), Jenny Gu (Editor), Philip E. Bourne (Editor)

2. D.W. Mount Bioinformatics: Genome and Sequence Analysis: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
3. Molecular Modeling: Principles & Applications, Andrew R. Leach, Prentice Hall