

STRUCTURE AND SYLLABUS OF MSc COURSEWORK
RECOMMENDED BY THE
BOARD OF STUDIES (CENTRE FOR COMPUTATIONAL SCIENCES)
FOR
MSc Life Science (Bioinformatics)

2015-16

Central University of Punjab
Bathinda-151001

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Eligibility Criterion for MSc Life Science (Bioinformatics) approved by BOS

Bachelor's degree in any branch of Life Sciences/ Pharmaceutical Sciences/ Mathematical Sciences/ Computer Sciences (or applications)/ Physical Sciences/ Chemical Sciences/ Veterinary Sciences/ Agricultural Sciences / Medical Sciences or B.Tech in CSE/IT/BioTech with 55% marks from a recognized Indian or foreign university.

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Certificate

The Board of Studies of Centre for Bioinformatics certifies that the syllabus of MSc Life Science (Bioinformatics) has been designed to ensure maximal overlap with the CSIR-NET and BINC syllabus.

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Program Objectives or Expected Skill Development among Students of Bioinformatics

In line with the syllabus of MSc Life Science (Bioinformatics) it is expected that a student graduating after successful completion of the course shall be

1. Proficient in various aspects of Bioinformatics.
2. Competent to carry out understanding complex information from the concurrent scientific literature, identify the knowledge lacunae, shortlist attainable objectives, design comprehensive methodology and carry out the unsupervised research.
3. Shall have scientific temperament.

Multiple courses shall be opted by students from other (allied) departments, however, concerned teacher shall have to use examples from relevant discipline so as to gravitate the students more towards Bioinformatics.

Therefore graduated students of MSc Life Science (Bioinformatics) would be a valuable asset for nation by virtue of his/her scientific abilities. The student can expect gainful employment in academic / research / industry by undertaking this course. A special effort has been made to enable the student clear national level tests, especially, CSIT-NET and BINC.

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M.Sc. Life Sciences (Bioinformatics)

Semester-1

S.No +	Paper Code	Course Title	Course Type	L	T	P	Cr	% Weightage				
								a	b	c	d	e
1	LBI.501	Research Methodology	F	2	-	-	2	25	25	25	25	50
2	LBI.502	Introduction to Biostatistics	E	2	-	-	2	25	25	25	25	50
3	LBI.504	Introduction to Cell Biology	E	3	-	-	3	25	25	25	25	75
4	LBI.506	Basics of Biochemistry	C	3	-	-	3	25	25	25	25	75
5	LBI.508	Concepts of Genetics	E	3	-	-	3	25	25	25	25	75
6	LBI.503	Biostatistics (P)	F	-	-	2	1	-	-	-	-	25
7	LBI.505	Cell Biology (P)	E	-	-	2	1	-	-	-	-	25
8	LBI.507	Biochemistry (P)	C	-	-	2	1	-	-	-	-	25
9	LBI.509	Genetics (P)	E	-	-	2	1	-	-	-	-	25
10	LBI.599	Credit Seminar	E			2	1	-	-	-	-	25
11		Elective Course 1*		4	-	-	4	25	25	25	25	100
12		Interdisciplinary Course-1		2	-	-	2	25	25	25	25	50
		Total Sem-1		19	0	10	24	-	-	-	-	600
Opt any one course from the following Elective courses (from within the department)												
13	LBI.510	Basic Sciences for Bioinformatics	E	2	-	-	4	25	25	25	25	100
Interdisciplinary courses for other departments												
14	LBI.301	Bioinformatics	E	2	-	-	2	25	25	25	25	50

- a. Continuous Assessment: Based on Objective Type Tests
b. Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
c. Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
d. End-Term Exam (Final): Based on Objective Type Tests
e. Total Marks

* More Shall be offered later

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Semester 2												
S.No.	Paper Code	Course Title	Course Type	L	T	P	Cr	% Weightage				
								a	b	c	d	E
14	LBI.512	Human Physiology	E	3	-	-	3	25	25	25	25	75
15	LBI.513	Essentials of Immunology	C	2	-	-	2	25	25	25	25	50
16	LBI.514	Sequence Analysis	C	4	-	-	4	25	25	25	25	100
17	LBI.515	Concepts of Molecular Biology	E	3	-	-	3	25	25	25	25	75
18	LBI.517	Molecular Modeling and Dynamics	C	4	-	-	4	25	25	25	25	100
19	LBI.516	Molecular Biology (P)	E	-	-	2	1	-	-	-	-	25
20	LBI.518	Molecular Modeling and Dynamics (P)	C	-	-	4	2	-	-	-	-	50
21	LBI.519	Elective Course-2 (P)	C	-	-	2	1	-	-	-	-	25
22		Elective Course-2*		2	-	-	2	25	25	25	25	50
23		Interdisciplinary course-2		2	-	-	2	25	25	25	25	50
		Total Sem-2		20	0	8	24					600
Opt any one course from the following Elective courses (from within the department)												
25	LBI.520	Database Management Systems	C	2	-	-	2	25	25	25	25	50
Interdisciplinary course for other departments												
26	LBI.401	Molecular Phylogenetics	E	2	-	-	2	25	25	25	25	50

- a. Continuous Assessment: Based on Objective Type Tests
b. Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
c. Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
d. End-Term Exam (Final): Based on Objective Type Tests
e. Total Marks
* More Shall be offered later

Note: Guides and topics for MSc Dissertation shall be assigned in this semester and synopsis shall have to be submitted in the second month of Third semester.

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Semester-3												
S.No.	Paper Code	Course Title	Course Type	L	T	P	C r	% Weightage				
								a	b	c	d	e
27	LBI.601	Ecology and Environment	E	3	-	-	3	25	25	25	25	75
28	LBI.602	Evolutionary and Developmental Biology	E	3	-	-	3	25	25	25	25	75
29	LBI.603	Microbiology	F	3	-	-	3	25	25	25	25	50
30	LBI.604	Complex Algorithms in Bioinformatics	C	3	-	-	3	25	25	25	25	100
31	LBI.605	Complex Algorithm in Bioinformatics (P)	C	-	-	4	2	-	-	-	-	50
32	LBI.606	Microbiology (P)	F	-	-	4	2	-	-	-	-	50
33	LBI.698	Dissertation Research		-	-	20	10	-	-	-	-	200
		Total Sem-3		12	0	24	24					600

- a. Continuous Assessment: Based on Objective Type Tests
- b. Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
- c. Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
- d. End-Term Exam (Final): Based on Objective Type Tests
- e. Total Marks

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Semester-4												
S.No.	Paper Code	Course Title	Course Type	L	T	P	C r	% Weightage				
								a	b	c	d	e
34	LBI.607	Systems Biology	C	4	-	-	4	25	25	25	25	100
35	LBI.608	Molecular Evolution	C	4	-	-	4	25	25	25	25	100
38	LBI.699	Dissertation		-	-	32	1 6	-	-	-	-	400
		Total Sem-4		6	0	32	2 4					600

- a. Continuous Assessment: Based on Objective Type Tests
- b. Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
- c. Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
- d. End-Term Exam (Final): Based on Objective Type Tests
- e. Total Marks

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Course Title: Research Methodology
Paper Code: LBL501
Semester: I

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student learns basis of scientific research to arrive at and verify the conclusions drawn.

Unit 1 **10 Lectures**

General principles of research: Meaning and importance of research, critical thinking, formulating hypothesis and development of research plan, review of literature, interpretation of results and discussion.

Unit 2 **5 Lectures**

Technical writing: Scientific writing that includes the way of writing Synopsis, research paper, poster preparation and presentation, and dissertation.

Unit 3 **6 Lectures**

Library: Classification systems, e-Library, web-based literature search engines

Unit 4 **15 Lectures**

Entrepreneurship and business development: Importance of entrepreneurship and its relevance in career growth, characteristics of entrepreneurs, developing entrepreneurial competencies, types of enterprises and ownership (large, medium SSI, tiny and cottage industries, limited, public limited, private limited, partnership, sole proprietorship) employment, self-employment and entrepreneurship, financial management-importance and techniques, financial statements- importance and its interpretation, and Intellectual Property Rights (IPRs).

Suggested Reading:

1. Gupta, S. (2005). *Research methodology and statistical techniques*. Deep & Deep Publications (p) Ltd. New Delhi.
2. Kothari, C.R. (2008). *Research methodology (s)*. New Age International (p) Limited. New Delhi.
3. *Research Methodology: Theory and Techniques* by Jagdish R. Raiyani
4. Standard /Reputed Journal authors' instructions.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Course Title: Introduction to Biostatistics
Paper Code: LBL502
Semester: I

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student learns basis of scientific research and statistical methods to arrive at and verify the conclusions drawn.

Unit 1 **6 Lectures**

Overview of Biostatistics: Difference between parametric and non-parametric statistics, Univariate and multivariate analysis, Confidence interval, Errors, Levels of significance, Hypothesis testing.

Unit 2 **8 Lectures**

Descriptive statistics: Measures of central tendency and dispersal, Histograms, Probability distributions (Binomial, Poisson and Normal), Sampling distribution, Kurtosis and Skewness.

Unit 3 **8 Lectures**

Experimental design and analysis: Sampling techniques, Sampling theory, Various steps in sampling, collection of data-types and methods.

Unit 4 **14 Lectures**

Inferential Statistics: Student's t-test, Paired t-test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two-way analysis of variance (ANOVA), Critical difference (CD), Least Significant Difference (LSD), Kruskal-Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks, χ^2 test. Standard errors of regression coefficients, Comparing two regression lines, Pearson Product-Moment Correlation Coefficient, Spearman Rank Correlation Coefficient, Power and sampling size in correlation and regression.

Suggested Reading:

1. Gookin, D. (2007). *MS Word 2007 for Dummies*. Wiley, USA.
2. Johnson, S. (2009). *Windows 7 on demand*. Perspiration Inc. USA.
3. Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials*. 3/e (with SPSS). Decker Inc. USA.
4. Sokal, R.R. and Rohlf, F.J. (1994). *Biometry: The Principles and Practices of Statistics in Biological Research*. W.H. Freeman publishers, USA.
5. Thurrott, P. and Rivera, R. (2009). *Windows 7 Secrets*. Wiley, USA.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Course Title: Introduction to Cell Biology
Paper Code: LBL504
Semester: I

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective and Learning Outcomes: This objective of the subject is to ensure that a student understands the following

- a. The structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- b. The structural aspects organelles.
- c. The process of mitotic cell division.
- d. The influences of changes or losses in cell function; including the responses to environmental or physiological changes, or alterations of cell function brought about by mutation.
- e. The procedure of cell signaling.

Unit 1 **25 Lectures**

Introduction to the cell: Evolution of the cell, From molecules to first cell, From prokaryotes to eukaryotes, Prokaryotic and eukaryotic genomes, Single cell to multicellular organisms.

Membrane structure and function: Models of membrane structure, Membrane proteins, Membrane carbohydrates, Membrane transport of small molecules, Membrane transport of macromolecules and particles. Structural organization and function of intracellular organelles: The lysosomes, Ribosomes, The peroxisomes, The golgi apparatus, The endoplasmic reticulum, Mitochondria and chloroplast, Structure of mitochondria and chloroplast, Oxidation of glucose and fatty acids, Electron transport oxidative phosphorylation, Chloroplast and photosynthesis.

Unit 2 **15 Lectures**

Protein secretion and sorting: Organelle biogenesis and protein secretion, synthesis and targeting, of mitochondria, chloroplast, peroxisomal proteins, translational modification in the ER. Intracellular traffic, vesicular traffic in the secretory pathway, protein sorting in the Golgi bodies, traffic in the endocytic pathway, exocytosis.

Unit 3 **17 Lectures**

The cytoskeleton: The nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and centrioles, Organization of the cytoskeleton. **Cell communication and cell signaling:** Cell adhesions, Cell junctions and the extra cellular matrix, Cell-cell adhesion and communication, Cell matrix adhesion, Collagen the fibrous protein of the matrix, Noncollagen component of the extra cellular matrix.

Unit 4 **15 Lectures**

Cell growth and division: Overview of the cell cycle and its control, The molecular mechanisms for regulating mitotic and meiotic events, Amitosis, Cell cycle control, Checkpoints in cell cycle regulation. Cell to cell signaling, Overview of the extra cellular signaling, Identification of cell surface receptors, G-protein coupled receptors and their effectors, Second messengers, Enzyme-linked cell surface receptors, Interaction and regulation of signaling pathways.

Suggested reading:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2010). *Molecular Biology of the cell*. Garland publishers, Oxford.
2. Celis, J.E. (2006). *Cell biology: A laboratory handbook*, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P.K. (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.
4. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons. Inc. New Delhi, India.
5. Recent Nobel Laureates in Cell Biology

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001

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Course Title: Introduction to Biochemistry

Paper Code: LBI.506

Semester: I

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective and Learning Outcomes: This objective of the subject is to ensure that a student understands the following

- a. The structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- b. The energy metabolism by cellular components in cells.
- c. The process of mitotic cell division.
- d. Influences of changes or losses in cell function; including the responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Unit 1

15 Lectures

Principles of biophysical chemistry pH, Buffer, Reaction kinetics, Thermodynamics, Colligative properties, Structure of atoms, Molecules and chemical bonds. Stabilizing interactions: Van der Waals, Electrostatic, Hydrogen bonding, Hydrophobic interaction, etc.

Unit 2

25 Lectures

Composition, structure and function of Biomolecules: Carbohydrates, Lipids, Proteins, Nucleic acids and Vitamins. Bioenergetics and metabolism of Carbohydrates, Lipids, Amino Acids and Nucleotides.

Unit 3

17 Lectures

Enzymology: Classification, Principles of catalysis, Mechanism of enzyme catalysis, Enzyme kinetics, Enzyme regulation, Isozymes Clinically important enzymes.

Unit 4

15 Lectures

Protein Chemistry: Ramachandran plot, Secondary, Tertiary and Quaternary structure, Domains, Motif and Folds. Nucleic acids: A-, B-, Z-DNA, tRNA, micro-RNA, Stability of protein and Nucleic acid structures.

Suggested Reading:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2010). *Biochemistry*. W.H. Freeman & Company. USA.
2. Brown, T.A. (2006). *Gene Cloning and DNA analysis: In Introduction*. Blackwell Publishing Professional. USA.
3. Haynie, D.T. (2007). *Biological thermodynamics*. Cambridge University. UK.
4. Mathews, C.K., Van Holde, K.E. and Ahern, K.G. (2000). *Biochemistry*. Oxford University Press Inc. New York.
5. Nelson, D. and Cox, M.M. (2013). *Lehninger Principles of Biochemistry*. BI publications Pvt. Ltd. Chennai, India.
6. Ochiai, E. (2008). *Bioinorganic chemistry: A survey*. Academic Press. Elsevier, India.
7. Randall, D. J., Burggren, W. and French, K. (2001). *Eckert animal physiology*. W.H. Freeman & Company. USA.
8. Raven, P.H., Johnson, G.B. and Mason, K.A. (2007). *Biology*. Mcgraw-Hill. USA.
9. Shukla AN (2009). *Elements of enzymology*. Discovery Publishing. New Delhi, India.
10. Voet, D. and Voet, J.G. (2014). *Principles of biochemistry*. CBS Publishers & Distributors. New Delhi, India.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Course Title: Concepts of Genetics
Paper Code: LBL508
Semester: I

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective and Learning Outcomes: This objective of the subject is to ensure that a student understands the following

- a. The structures and organisation of nucleic acids.
- b. DNA replication.
- c. Inheritance patterns

Unit 1 **20 Lectures**

Introduction and scope of genetics, DNA as genetic material: The vehicles of inheritance, Chemical structure and base composition of nucleic acids, Double helical structure, Structure of DNA and RNA, Different types of DNA molecules, forces stabilizing nucleic acid structure, super coiled DNA, properties of DNA, denaturation and renaturation of DNA and Cot curves. **DNA replication:** Messelson and Stahl Experiment, Carins Experiment, Okazaki Experiment, Basic mechanism of DNA replication.

Unit 2 **17 Lectures**

Cell division and Cell cycle: Mitosis, Meiosis, Chromosomal basis of inheritance. Basic principles of Mendelian inheritance: Segregation and independent assortment, Alleles and multiple alleles, Human pedigrees and inheritance. Linkage analysis and gene mapping: Coupling and repulsion phase linkage, Crossing over and recombination. Population genetics: Application of Mendel's laws to populations, Hardy-Weinberg principle, inbreeding depression and heterosis, inheritance of quantitative traits.

Unit 3 **17 Lectures**

Gene Interaction: Sex determination and Sex linked inheritance, Sex determination in humans, *Drosophila* and other animals, Sex determination in plants, Sex linked genes and dosage compensation. Human genetics: pedigree analysis. Gene concept: Fine structure of gene and gene concept, Fine structure analysis – Benzer's experiments, Complementation analysis and fine structure of gene, Complementation and recombination, Concept of gene.

Unit 4 **18 Lectures**

Extra-chromosomal inheritance: Chloroplast and Mitochondrial inheritance, Yeast, *Chlamydomonas/Neurospora* and higher plants Chromosomal aberrations: Types of changes– deletions, duplications, inversions, translocations, Change in chromosome number: trisomy and polyploidy. Evolutionary history of bread wheat, Aneuploids–nullisomics, monosomics, and trisomics, Somatic aneuploids, Changes in chromosome structure, Properties of chromosomes for detection of structural changes. Mutations: Spontaneous and induced mutations, Somatic vs germinal mutation.

Suggested Reading:

1. Anthony, J.F., Miller, J.A., Suzuki, D.T., Richard, R.C., Gilbert, W.M. (1998). *An introduction to Genetic Analysis*. W.H. Freeman publication, USA.
2. Atherly, A.G., Girton, J.R., McDonald, J.F. (1999). *The science of Genetics*. Saundern College publication.
3. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
4. Gupta, P.K. (2009). *Genetics*. Rastogi publications, Meerut, India.
5. Gupta, P.K (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.
6. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.
7. Schaum, W.D. (2000). *Theory & problems in Genetics by Stansfield, out line series* McGrahill, USA.
8. Tamarin, R.H. (1996). *Principles of Genetics, International edtn*. McGrawhill, USA.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001

Centre for Computational Sciences

Course Title: Basic Sciences for Bioinformatics

Paper Code: LBL510

Semester: I

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective and Learning Outcomes: This course shall act as bridge course for the students of biology back-ground and is designed to brush-up their knowledge on fundamentals of Chemistry, Physics and Mathematics **in terms of application of these concepts in Bioinformatics**. The course is essential enabling students

Unit 1

16 Hours

Vector-addition, subtraction, dot, cross, scalar triple product, divergence and curl. System of linear equations. Matrix inverse, eigenvalue, eigenvector, principal m component analysis
Mathematical modeling and simulation: Markov process, Bayesian Statistics.

Unit II

15 Hours

Basics of classical mechanics and quantum mechanics, Laws of motion, Refraction of light, focal length of lens, magnification. Definition of resolution, optical and electron microscope, Principles of lasers, Luminescence, fluorescence and phosphorescence (basic concepts and applications).

Unit III

14 Hours

Chromatography. Application of spectroscopy (fluorescence and absorption spectroscopy) and X-ray diffraction for determination of biomolecular secondary and tertiary structure – CD, NMR, X - ray crystallography, mass spectroscopy of biological molecules.

Unit IV

11 Hours

Basic principle of chemical kinetics – Zero order and first order kinetics, energy of activation.
Reversible and irreversible thermodynamics.

Suggested Reading

1. Fundamentals of Physics by Resnick and Halliday (2014, Wiley India)
2. Mathematics by R.S. Agrawal; S.Chand Publishing (2014)
3. Organic chemistry by Morrison and Boyd 7th Edition (2013)
4. Physical Chemistry by A. J. Mee, James Clare Speakman, Heinemann Educational Publishers (1993)
5. Spectroscopy: Fundamentals and data interpretation by Neera Kumar Fuloria, Studium Press India Pvt. Ltd.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Course Title: Bioinformatics
Paper Code: LBL511
Semester: I

L	T	P	Credits	Marks
2	0	0	2	50

For other departments only

Course Objective and Learning Outcomes: Bioinformatics course is being offered to the students as fundamental course to brush up the basics of the students in this important emerging area. Students will be composed to the concepts of data mining, computational and algorithmic tools for biological data analysis and are expected to get a good idea on using computational resources to understand and resolve biological problems.

Unit I

10hours

Biological databases: Nucleotide Sequence Databases, GenBank, DDBJ, EMBL, Sequence Flatfile and submission process, Protein sequence databases, UniProt in detail, Mapping databases, Genomic databases, Data mining.

Unit II

15hours

Sequence analysis: Gene Prediction methods and programs, Promoter analysis, RNA secondary structure thermodynamics, Refining multiple sequence alignment based on RNA secondary structure predictions, SNP discovery methods and databases, Genotyping, International haplotype map project, 1000 genomes project.

Analysis for protein sequences: Predicting features of individual residues, Predicting function, Neural networks, Protein structure prediction, Protein structure databases, PDB in detail, 3D visualization softwares, Pathway and molecular interaction databases,

Unit III

16hours

Inferring relationships: Global Vs. local sequence alignments, Dotplots, Scoring matrices, Pairwise sequence alignment, BLAST, Position-Specific scoring and PSI-BLAST, MegaBLAST, BL2SEQ, BLAT, FASTA Vs BLAST, Protein multiple sequence alignments, Multiple structural alignments, Shotgun sequencing, Sequence assembly and finishing.

Unit IV

15hours

Modelling and structure: From protein sequence to structure, theoretical and practical aspects of protein sequence alignments, secondary, tertiary structure prediction, comparative modeling, Docking, protein-protein and protein-ligand docking. Techniques for 3-D structure determination like X-ray, NMR, MS/MS analysis.

Computational drug designing: Structure-based drug design, virtual screening, quantitative structure activity relations, Cheminformatics and pharmacophore mapping in therapeutic development.

Suggested reading

1. Baxevanis, A.D. and Ouellette, B.F.F. (2005). *Bioinformatics: A Practical guide to the Analysis of Genes and Proteins*. Wiley-Interscience, USA.
 2. Hall, B.G. (2011). *Phylogenetic Trees Made Easy: A How-To Manual*. Sinauer Associates, Inc. USA.
 3. Lesk, A.M. (2008). *Introduction to Bioinformatics*. Oxford University Press, UK.
 4. Zvelebil, M. and Baum, J. (2007). *Understanding Bioinformatics*, Garland Science, New York, USA.
 5. Ramsden, J. (2010). *Bioinformatics: An Introduction (Computational Biology)*. Springer, India.
 6. Ye, S.Q. (2008). *Bioinformatics: A Practical approach*. Chapman & Hall/CRC, UK.
 7. Mount, D. (2012). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press.
 8. Graur, D., Li, W. H. (2000). *Fundamentals of Molecular Evolution*. Sinauer Associates.
 9. Tisdall, J. (2001). *Beginning Perl for Bioinformatics*. O'Really Publishers.
 10. Orengo, C., Jones, D., Thornton, J. (2005). *Bioinformatics: Genes, Proteins and Computers (Advanced Texts)*. Taylor and Francis Publishers.
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CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Course Title: Biostatistics (Practical)
Paper Code: LBL503
Semester: I

L	T	P	Credits	Marks
0	0	2	1	25

1. Experimental design and analysis.
2. Training on basic usage of Microsoft Word, Microsoft Excel, Microsoft PowerPoint and Internet Explorer.
3. Optimizing web search: Google advanced search, Boolean operators, Literature search using Google Scholar, HighWire.
4. Bibliography management and research paper formatting using reference software EndNote.
5. Performing statistics analyses using MS Excel Analysis toolpack.
6. Creating a functional website using HTML.
7. Basic programming using DOS batch files and Auto Hot Key.

*More practicals may be added/modified from time to time depending on available faculties/facilities.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Course Title: Cell Biology (Practical)

Paper Code: LBL505

Semester: I

L	T	P	Credits	Marks
0	0	2	1	25

1. Good Lab Practices – Lab safety /calibration of instruments/ Handling Chemicals.
 2. Preparation of mitotic & meiotic chromosomes.
 3. Study of structure of cell organelles through electron micrographs.
 4. Instrumental methods for cell biology-centrifugation, chromatography.
 5. Bacterial staining and identification.
 6. Sectioning of tissues (Plant and animal).
 7. Histochemical techniques (Fixing, Processing, Staining).
- *More practicals may be added/modified from time to time depending on available faculties/facilities.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Course Title: Biochemistry (Practical)

Paper Code: LBL507

Semester: I

L	T	P	Credits	Marks
0	0	2	1	25

1. Preparation of Solutions, buffers, pH setting etc.
2. Amino acid and carbohydrate separations by paper & thin layer chromatography.
3. Quantitative Estimation of Proteins, Sugars, total lipids and amino acids.
4. Assay and estimation of different enzymes e.g. invertase, amylases, acid and alkaline phosphatases in plant seeds.
5. Principle and application of electrophoresis, Native, SDS PAGE.
6. Estimation of total phenolic compounds.
7. Extraction and estimation of vitamins.

*More practicals may be added/modified from time to time depending on available faculties/facilities.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
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Course Title: Genetics (Practical)
Paper Code: LBL509
Semester: I

L	T	P	Credits	Marks
0	0	2	1	25

1. Calculation of allele frequencies.
2. Calculating recessive gene frequency, Calculating frequency of sex –linked alleles.
3. Karyotyping of normal & abnormal chromosome sets.
4. Monohybrid and dihybrid ratios, Multiple alleles, Epistasis – Problems.
5. Inheritance patterns in Man – Numericals on Pedigree analysis- Autosomal patterns, X–linked patterns, Y–linked patterns.
6. Mitochondrial inheritance patterns.
7. To test PTC tasting ability in a random sample and calculate gene frequencies for the taster and non–taster alleles.
8. Identification of inactivated X chromosome as Barr body and drumstick.
9. Blood group typing using haemagglutination tests.
10. Studies of a Model organism: Identification of normal and mutant flies (*Drosophila melanogaster*) & Preparation of *Drosophila* polytene chromosomes.
11. To study fingerball and palmar dermatoglyphics and calculate indices.
12. To test for colour blindness using Ishihara charts.
13. Molecular Mapping of Genes.

*More practicals may be added/modified from time to time depending on available faculties/facilities.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Credit Seminar

Paper Code: LBI.599

Semester: I

L	T	P	Credits	Marks
0	0	2	1	25

Objective: The objective of Credit Seminar would be to ensure that the student learns the aspects of the seminar presentation. Herein, the student shall have to present a selective overview of a scientific problem with focus of literatural knowledge.

The evaluation criteria shall be as follows:

Maximum Marks: 25

S.No.	Criteria	Marks
1	Content	10
2	Presentation Skills	10
3	Handling of queries	5

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Introduction to Computational Sciences

Paper Code: CCS.452

Total Lectures: 36

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective and Learning Outcomes: This course has been designed to provide an introductory understanding of the broad field of Computational Sciences. The course covers various aspects of the field and attempts to provide a bird's eye view of the scientific potential of this growing field.

Unit-I^{1,5} (09)

Introduction: Overview of Computational Sciences and its applications to Natural Sciences, Nobel Prize winners in Computational Natural Sciences and their contributions to the field, Modelling process and its types, Computational Toolbox- errors and their types, rate of change, fundamental concepts of integral calculus, Importance of Learning Computer Programming in Computational Natural Sciences.

Unit-II^{2,5}

Applications of Computational Sciences in Chemistry (09)

Computational Quantum Chemistry and its applications, Prediction of Molecular Properties using Computational Chemistry, Overview of Quantum Chemistry Theories and their level of accuracy and hierarchy of computational requirements, Overview of Computer aided drug design and QSAR, Promises of Computational Chemistry

Unit-III^{3,5}

(09)

Applications of Computational Sciences in Physics

Computational Sciences in Molecular Physics, Computational Modeling of materials and prediction of material properties, Overview of Computational Fluid Dynamics and Computational Biophysics, Modeling force and motion, Overview of Cellular Automata Simulations, promises of Computational Physics

Unit IV^{4,5}

Applications of Computational Sciences in Life Sciences (09)

Overview of Computational Biology and bioinformatics, Structural Bioinformatics, Genomic data and its interpretation, Molecular Dynamics Simulations on Biological Systems, Hybrid Computational Methods for Studying Structure, Dynamics and Functions of Large Biological Systems, Promises of Computational Biology.

Recommended Books and References:

1. A. B. Shiflet and G. W. Shiflet. Introduction to Computational Sciences (Overseas Press (India) Pvt. Ltd., New Delhi, India), 2011.
2. F. Jensen. Introduction to Computational Chemistry (Second Edition, Wiley), 2007.
3. J. Hasbun, P. Devries. A First Course in Computational Physics. (Viva Books Pvt. Ltd., New Delhi), 2011.
4. D. W. Mount. Bioinformatics (2nd Edition, Cold Spring harbour Press, New Jersey), 2004.
5. Some examples will be taken from Selected Articles from Standard /Reputed Journals.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Interdisciplinary (from other department)
Semester: I

L	T	P	Credits	Marks
2	0	0	2	50

Paper Code: Code shall be brought from the department whose course is undertaken by the student.

Course Objective and Learning Outcomes: To ensure holistic development of student's knowledge and perspective, a course from other department must be undertaken by the student. This course shall carry 2 credits and will be evaluated out of 50 Marks.

First Semester Over

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Semester 2												
S.No	Paper Code	Course Title	Course Type	L	T	P	Cr	% Weightage				
								a	b	c	d	e
14	LBI.512	Human Physiology	E	3	-	-	3	25	25	25	25	75
15	LBI.513	Essentials of Immunology	C	3	-	-	2	25	25	25	25	75
16	LBI.514	Sequence Analysis	C	3	-	-	4	25	25	25	25	75
17	LBI.515	Concepts of Molecular Biology	E	3	-	-	3	25	25	25	25	75
18	LBI.517	Molecular Modeling and Dynamics	C	4	-	-	4	25	25	25	25	100
19	LBI.516	Molecular Biology (P)	E	-	-	2	1	-	-	-	-	25
20	LBI.518	Molecular Modeling and Dynamics (P)	C	-	-	4	2	-	-	-	-	50
21	LBI.519	Elective Course-2 (P)	C	-	-	2	1	-	-	-	-	25
22		Elective Course-2*		2	-	-	2	25	25	25	25	50
23		Interdisciplinary course-2		2	-	-	2	25	25	25	25	50
		Total Sem-2		20	0	8	24					600
Opt any one course from the following Elective courses (from within the department)												
25	LBI.520	Database Management Systems	C	2	-	-	2	25	25	25	25	50
Interdisciplinary course for other departments												
26	LBI.401	Molecular Phylogenetics	E	2	-	-	2	25	25	25	25	50

- a. Continuous Assessment: Based on Objective Type Tests
b. Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
c. Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
d. End-Term Exam (Final): Based on Objective Type Tests
e. Total Marks
* More Shall be offered later

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Human Physiology
Paper Code: LBL512
Semester: II

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective and Learning Outcomes: This course is designed to provide students with an understanding of the function and regulation of the human body and physiological integration of the organ systems to maintain homeostasis. Course content will include neural & hormonal homeostatic control mechanisms, as well as study of the musculoskeletal, circulatory, respiratory, digestive, urinary, immune, reproductive, and endocrine organ systems.

Unit: 1 **14 Lectures**

Muscle Physiology: Types of muscles, Properties; Contractile force; Motor Unit. Skeletal, cardiac and smooth muscles.

Cardiovascular system: Myogenic heart, Cardiac cycle, Heart as a pump, blood pressure, neural and chemical regulation of all above, Blood cell synthesis and Bone marrow, Haemopoiesis and formed elements, Plasma function, Blood volume and its regulation, Blood groups, Haemoglobin, Haemostasis, blood associated diseases.

Unit: 2 **12 Lectures**

Digestive system: Digestion, absorption, energy balance, BMR, Epithelial Barrier Function, Regulation of Swallowing and Gastric Emptying and small/ Large Bowel. Gastro-intestinal Secretions and accessory glands

Respiratory system: Anatomical considerations, Transport of gases, Exchange of gases, Waste elimination, Neural and chemical regulation of respiration. Alveolar Ventilation, Diffusion across alveoli. Transport of respiratory Gases in blood. The Respiratory System under Stress: Altitude, Hypoxia

Excretory system: Comparative physiology of excretion, Kidney, Urine formation, Urine concentration, Waste elimination, Micturition, Regulation of water balance, Electrolyte and acid-base balance. Renal Function and Hemodynamics

Unit: 3 **14 Lectures**

Nervous system: Neurons, action potential, Gross neuroanatomy of the brain and spinal cord, Central and peripheral nervous system, Neural control of muscle tone and posture. **Sense organs:** Vision, hearing and tactile response.

Thermoregulation and stress adaptation: Comfort zone, Body temperature – physical, chemical, Neural regulation, Acclimatization.

Unit: 4 **14 Lectures**

Endocrinology: Endocrine glands, Hormone Structure and Function, Basic mechanism of hormone action, Hormones and diseases, Reproductive processes, Neuroendocrine regulation.

Reproduction: Males and female reproductive system. Gametogenesis, fertilization and early development.

Suggested Reading:

1. Brody, T. (1998). *Nutritional biochemistry*. Academic Press, USA.
2. Devlin, T.M. (2005). *Textbook of Biochemistry with clinical correlations*. John Wiley & Sons Inc. USA.
3. Guyton. (2007). *Textbook of medical physiology*. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
4. Hill, R.W, Wyse, G. A. and Anderson, M. (2008). *Animal physiology*. Sinauer Associates Inc. USA.
5. Khurana. (2006). *Textbook of medical physiology*. Elsevier India Pvt. Ltd.
6. Murray, R.K. (2009). *Harper's illustrated biochemistry*. Jaypee Publishers, New Delhi, India.
7. Tyagi, P. (2009). *A textbook of Animal Physiology*. Dominant Publishers and distributors, New Delhi, India.
8. Silverthorn D, (2011) *Human Physiology*, Pearson; 6th edition.
9. Sherman V. (2013) *Vander's Human Physiology*. McGraw-Hill 13th edition.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Essentials of Immunology
Paper Code: LBL513
Semester: II

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective and Learning Outcomes: The objective of this course is to cover basic concepts of immune system and to understand the concept of immune-based diseases as either a deficiency of components or excess activity as hypersensitivity.

Unit: 1 **12 Lectures**

Immune system: The cells and organs of immune system. Recognition of self and nonself, Humoral immunity-immunoglobulins, basic structure, classes and subclasses, structural and functional relationships, nature of antigen, antigen-antibody reaction, estimation of affinity constants. Molecular mechanisms of antibody diversity and Cellular immunity: Organization of genes coding for constant and variable regions of heavy chains and light chains. Mechanisms of antibody diversity, class switching. Lymphocytes, cytokines, interferons, Interlukins, antigen recognition-membrane receptors for antigens.

Unit: 2 **10 Lectures**

Immune Effectors: Complement system, their structure, functions and mechanisms of activation by classical, alternative and lectin pathway. Th1 and Th2 response, cytokines, Chemokines. Antigen and antibody interactions

Unit: 3 **10 Lectures**

Mechanisms of Immune System Diversity: Organization and expression of immunoglobulin genes, Mechanisms of antibody diversity, class switching. Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution, variation and their functions. Organization and rearrangement of T-cell receptor genes (TCR).

Unit: 4 **12 Lectures**

Immune System in Health and Diseases: Inflammation, hypersensitivity and autoimmunity, Immunity to microbes, immunity to tumors, AIDS and immunodeficiencies, hybridoma technology and vaccine development associated challenges for chronic and infectious diseases. Production, characterization and applications of monoclonal antibodies in diagnosis, therapy and basic research, concept of making immunotoxins.

Suggested Reading:

1. Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2007). *Kuby Immunology*. 7th Edition. W.H. Freeman, USA.
2. Abbas. (2008). *Cellular and Molecular Immunology*. CBS Publishers & Distributors, India.
3. Charles, A. and Janeway, J.R. (1994). *Immunobiology: The immune system in health and disease*. Blackwell Publishing, USA.
4. Delves, P.J., Roitt, I.M. and Seamus, J.M. (2006). *Roitt's essential immunology (Series-Essentials)*. Blackwell Publishers, USA.
5. Elgert, K.D. (2009). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.
6. Paul, W.E. (1993). *Fundamental immunology*. Raven Press, SD, USA.
7. Sawhney, S.K. and Randhir, S. (2005). *Introductory practical biochemistry*. Alpha Science International Ltd. New Delhi, India.
8. Tizard. (2008). *Immunology: An Introduction*. Cengage Learning, Thompson, USA.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Sequence Analysis
Paper Code: LBL514
Semester: II

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student learns various algorithms and softwares for the sequence analysis.

Unit 1

14 Hours

Various file formats for bio-molecular sequences: GenBank, FASTA, GCG, MSF etc. Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues **Scoring matrices:** basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, principles based on which these matrices are derived Database Searches: Keyword - based Entrez and SRS; Sequence-based: BLAST & FASTA; Use of these methods for sequence analysis including the on-line use of the tools and interpretation of results from various sequence and structural as well as bibliographic databases.

Unit 2

14 Hours

Pairwise sequence alignments: basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties, use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results.

Unit 3

14 Hours

Multiple sequence alignments (MSA): the need for MSA, basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW and PileUp and their application for sequence analysis (including interpretation of results), concept of dandrogram and its interpretation.

Unit 4

14 Hours

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, various types of pattern representations viz. consensus, regular expression (Prosite-type) and sequence profiles; profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

Phylogenetic analysis: Taxonomy and phylogeny: Basic concepts in systematics, taxonomy and phylogeny; molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees.

Suggested Reading:

1. A.D. Baxevanis *et. al.*, Current Protocols in Bioinformatics, (2005) Wiley Publishers
2. David W.Mount Bioinformatics (2001) Cold Spring Harbor Laboratory Press, ISBN 0-87969-608-7
3. Computational Molecular Biology by P. A. Pevzner, Prentice Hall of India Ltd, (2004) ISBN81-203-2550-8
4. D.E.Krane and M.L.Raymer Fundamental concepts of Bioinformatics (2003) Pearson Education ISBN 81-297-0044-1
5. N.Gautham Bioinformatics Narosa publications. (2006) ISBN-13: 9781842653005

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Concepts of Molecular Biology
Paper Code: LBL515
Semester: II

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective and Learning Outcomes: The objective of this course is to cover basic concepts of Molecular Biology

Unit: 1 **14 Lectures**

Structure, Conformation, Denaturation, Renaturation of Nucleic acids: Carrier of genetic information, Chemical structure of DNA and base composition, Watson-Crick model, Supercoiled DNA, Different forms of RNA: mRNA, tRNA, rRNA and other Types of RNA. Organelle DNA: mitochondria and chloroplast DNA. Chromosome Structure, Chromatin and the Nucleosome: Genome Sequence and Chromosome Diversity, Chromosome Duplication and segregation, The nucleosome, Chromatin structure: euchromatin, heterochromatin, Constitutive and facultative heterochromatin, Regulation of chromatin structure and nucleosome assembly, Nucleolus.

Unit: 2 **14 Lectures**

Gene & Genome organization: Split genes, Overlapping genes, Transposons & retrotransposons, Gene clusters, Histones, Non-histones, Nucleosome, Chromatin, Chromosome structure in prokaryotes & eukaryotes. Basic Processes, Replication of DNA: Prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, Enzymes and accessory proteins involved in DNA replication, Replication errors, DNA damage and their repair.

Unit: 3 **14 Lectures**

Transcription and mRNA processing: Prokaryotic & eukaryotic transcription, general and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and posttranscriptional gene silencing: Initiation, Elongation & Termination of transcription, Capping, Polyadenylation, Splicing, editing, mRNA stability, RNA interference, Microarray.

Unit: 4 **10 Lectures**

Translation: Genetic code, Prokaryotic & eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, co- and post-translational modifications of proteins, Epigenetics.

Suggested Reading:

1. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.
2. Gupta, P.K. (2005). *Cell and Molecular Biology*. Rastogi publications, Meerut, India.
3. James, D.W., Baker, T.A., Bell, S.P., Gann, A. (2009). *Molecular Biology of the Gene*. Benjamin Cummings, USA.
4. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.
5. Johnson, A., Lewis, J., Raff, M. (2007). *Molecular Biology of the Cell*. Garland Science, USA.
6. Lodish, H., Berk, A., Chris, A.K. and Krieger, M. (2008). *Molecular Cell Biology*. W.H. Freeman, USA.
7. Sambrook, J., Fritish, E.F., Maniatis, T. (2000). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Molecular Modeling and Dynamics
Paper Code: LBL517
Semester: II

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student learns modelling of biomolecular structures and understanding the dynamics of the structural transitions.

Unit 1

14 Hours

Biomolecular Modeling and Structure - molecular modeling today: overview of problems, tools, and solution analysis, minitutorials in protein and nucleic acid structure. Techniques for Conformational Sampling- Monte Carlo, global optimization, etc.

Unit 2

14 Hours

Molecular Mechanics: general features, bond stretching, angle bending, improper torsions, out of plane bending, cross terms, non-bonded interactions, Ramachandran diagram point charges, calculation of atomic charges, polarization, van der waals interactions, hydrogen bond interactions, Water models, Force field, all atoms force field and united atom force field.

Unit 3

14 Hours

Energy minimization: Steepest descent, conjugate gradient – Derivatives, First order steepest decent and conjugate gradients. Second order derivatives Newton-Raphson, Minima, maxima saddle points and convergence criteria.-non derivatives minimization methods, the simplex, sequential univariate, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, Solvent access, Equilibration, cut-offs.

Unit 4

14 Hours

Simulation methods : algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzmann velocity, time steps, duration of the MD run, Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions. Various methods of MD, Monte Carlo, systematic and random search methods. Differences between MD and MC, Energy, Pressure, Temperature, Temperature dynamics, simulation softwares. Various methods of MD, Monte Carlo, systematic and random search methods.

Suggested Readings:

1. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
 2. Fenniri, H. "Combinatorial Chemistry – A practical approach", (2000) Oxford University Press, UK.
 3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.
 4. Gordon, E.M. and Kerwin, J.F "Combinatorial chemistry and molecular diversity in drug discovery" (1998) Wiley-Liss Publishers.
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CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Database Management System
Paper Code: LBL520
Semester: II

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student learns various aspects of database management.

Unit 1

14 Hours

Database planning and Design concepts General Database Planning and Design – Document or forms – preparation and architecture Entity-Relational ship Model- entities, Attributes, keys, tables design, relationships, roles and dependencies. Advanced E-R model. - concepts.Relational Algebra and relational calculus- introduction-principles and uses for design. Mapping ER model to Relational DB. Normalization.

Unit 2

14 Hours

Relational DB Introduction to relational DB and transactions.SQL-statements-Data Definition-Manipulation-control-Objects, - Views, sequences and Synonyms. Working with code and forms- Front end development-query sublanguage-modifying relations in SQL.

Unit 3

14 Hours

Internals of RDBMS Physical data structures, query optimization. Join algorithm stistica and cost base optimization. Transaction processing.concurrency control and recovery management. Transaction model properities, state serizability, lock base protocols, two phase locking.

Unit 4

14 Hours

Database technologies: JDBC, ODBC standard and CORBA –extended entity relationship model, object data model UML diagram. File organizations and data structures. Distributed database environment and its overview. Different databases and internet. Use of XML.

Suggested Readings:

- 1 Abraham Silberschatz, Henry F.Korth and S.Sudhashan (2005) Database system concepts. 5 Ed McGraw Hill Publications.
 - 2 Elmasri Ramez and Novathe Shamkant, “ Fundamentals of Database systems” (2007) Benjamin cummings Publishing Company. ISBN-10: 0321369572.
 - 3 P. Ramakrishnan Rao: Database Management system, (2003) 3EdMcGraw Hill Publications. 9780071230575
 - 4 Jim Gray and A.Reuter “ Transaction processing : Concepts and Techniques” Morgan Kaufmann Press.(1997) ISBN-10: 1558601902
 - 5 V.K .Jain. Database Management system (2002) Dreamtech Press ISBN 8177222279
 - 6 Date C.J. “ Introduction to database management” (2009) Vol1, Vol2, Vol3 addison Wesley.
 - 7 Ullman, JD “ Principles of Database systems” (1992) Galgottia publication
 - 8 James Martin Principles of Database Management systems” (1985) PHI.
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CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Molecular Biology (Practicals)
Paper Code: LBL516
Semester: II

L	T	P	Credits	Marks
0	0	2	1	25

1. Isolation of genomic DNA from bacteria (E.coli) and human blood, Quantification of DNA using spectrophotometric method.
 2. RNA isolation.
 3. cDNA synthesis.
 4. RT-PCR.
 5. Isolation of plasmid DNA from bacteria.
 6. Transformation of bacteria using CaCl₂ heat shock method-Competent cell preparation.
 7. Digestion of DNA using restriction endonucleases, Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis.
 8. Construction of restriction map by single and double digestion, Designing DNA probe, Southern blot hybridization (demonstration only).
 9. Amplification of known DNA sequences by Polymerase Chain Reaction.
- *More practicals may be added/modified from time to time depending on available faculties/facilities.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Molecular Modeling and Dynamics
Paper Code: LBL518
Semester: II

L	T	P	Credits	Marks
0	0	4	2	50

1. Advanced Visualization Software and 3D representations with VMD and Rasmol.
2. Coordinate generations and inter-conversions.
3. Secondary Structure Prediction.
4. Fold Recognition, *ab initio method*.
5. Homology based comparative protein modeling.
6. Energy minimizations and optimization.
7. Validation of models.
 - a. WHATIF
 - b. PROSA
 - c. PROCHECK
 - d. VERIFY 3D
8. Protein Structure Alignment.
9. Modeller
10. Structure based Drug Design
 - a. Molecular Docking
 - b. De Novo Ligand Design
 - c. Virtual Screening
11. Ligand based Drug Design
 - a. Pharmacophore Identification
 - b. QSAR
12. Molecular Dynamics with Gromacs
13. Binding Site Identification

Suggested Reading

1. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
 2. Fenniri, H. "Combinatorial Chemistry – A practical approach", (2000) Oxford University Press, UK.
 3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.
 4. Gordon, E.M. and Kerwin, J.F "Combinatorial chemistry and molecular diversity in drug discovery" (1998) Wiley-Liss Publishers.
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CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Database Management System Lab

Paper Code: LBI.519

Semester: II

L	T	P	Credits	Marks
0	0	2	1	25

1. DDL & DML: Creating and working with databases, creating tables, dropping tables, primary and secondary keys, data validation, simple queries using MySQL, cursors, stored procedures.
2. Working with DBA: Different drivers, API for ODBC, JDBC.
3. Database architecture - preparation of forms – three tier architecture.
4. DTD and XML schema- simple DTD and creation of data in XML.
5. Design of database architecture - Design, planning, databases, UML Schema, Data models to physical tables.
6. Design of entity-relationship model using features from laboratory information systems. Normalization of data.
7. Database management: Authorization, Control and Security
8. Accessing molecular biology databases: Entrez, SRS, PIR
9. Databases: Retrieving, parsing and analysing sequences, structures etc

Suggested Readings:

- 1 Abraham Silberschatz, Henry F.Korth and S.Sudhashan (2005) Database system concepts. 5 Ed McGraw Hill Publications.
- 2 Elmasri Ramez and Novathe Shamkant, “ Fundamentals of Database systems” (2007) Benjamin cummings Publishing Company. ISBN-10: 0321369572.
- 3 P. Ramakrishnan Rao: Database Management system, (2003) 3EdMcGraw Hill Publications. 9780071230575
- 4 Jim Gray and A.Reuter “ Transaction processing : Concepts and Techniques” Morgan Kaufmann Press.(1997) ISBN-10: 1558601902
- 5 V.K .Jain. Database Management system (2002) Dreamtech Press ISBN 8177222279
- 6 Date C.J. “ Introduction to database management” (2009) Vol1, Vol2, Vol3 addison Wesley.
- 7 Ullman, JD “ Principles of Database systems” (1992) Galgottia publication
- 8 James Martin Principles of Database Management systems” (1985) PHI.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Molecular Phylogenetics

(Inter disciplinary for other departments)

L	T	P	Credits	Marks
2	0	0	2	50

Paper Code: LBI.521

Semester: II

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student learns about various approaches for understanding the molecular phylogenetics.

Unit 1

14 Hours

Mutational processes, evolution of mutation rates, evolution of DNA sequences,

Unit 2

14 Hours

The molecular clock, selection and genetic drift on the molecular level, nucleotide composition, polymorphism and SNPs.

Unit 3

14Hours

Phylogenetic trees and other models, optimality criteria for selecting phylogenetic hypothesis. Substitution models for DNA and other data types.

Unit 4

14Hours

Super trees, consensus trees, tree compatibility. Algorithms for evaluating the tree space; Markov Chain Monte Carlo, genetic algorithms. Evaluation of results from phylogenetic analyses, phylogenetic dating.

Suggested Reading

1. A.D. Baxevanis *et. al.*, Current Protocols in Bioinformatics, (2005) Wiley Publishers
 2. David W.Mount Bioinformatics (2001) Cold Spring Harbor Laboratory Press, ISBN 0-87969-608-7
 3. Computational Molecular Biology by P. A. Pevzner, Prentice Hall of India Ltd, (2004) ISBN81-203-2550-8
 4. D.E.Krane and M.L.Raymer Fundamental concepts of Bioinformatics (2003) Pearson Education ISBN 81-297-0044-1
 6. N.Gautham Bioinformatics Narosa publications. (2006) ISBN-13: 978184265300
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CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Interdisciplinary (from other department)

L	T	P	Credits	Marks
2	0	0	2	50

Paper Code: Code shall be brought from the department whose course is undertaken by the student.

Semester: II

Course Objective and Learning Outcomes: To ensure holistic development of student's knowledge and perspective, a course from other department must be undertaken by the student. This course shall carry 2 credits and will be evaluated out of 50 Marks.

Second Semester Over

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Semester-3												
S.No.	Paper Code	Course Title	Course Type	L	T	P	C r	% Weightage				
								a	b	c	d	e
27	LBI.601	Ecology and Environment	E	3	-	-	3	25	25	25	25	75
28	LBI.602	Evolutionary and Developmental Biology	E	3	-	-	3	25	25	25	25	75
29	LBI.603	Microbiology	F	3	-	-	3	25	25	25	25	50
30	LBI.604	Complex Algorithms in Bioinformatics	C	3	-	-	3	25	25	25	25	100
31	LBI.605	Complex Algorithm in Bioinformatics (P)	C	-	-	4	2	-	-	-	-	50
32	LBI.606	Microbiology (P)	F	-	-	4	2	-	-	-	-	50
33	LBI.698	Dissertation Research		-	-	20	10	-	-	-	-	200
		Total Sem-3		12	0	24	24					600

- a. Continuous Assessment: Based on Objective Type Tests
- b. Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
- c. Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
- d. End-Term Exam (Final): Based on Objective Type Tests
- e. Total Marks

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Ecology and Environment
Paper Code: LBL601
Semester: III

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student learns about various approaches for understanding of Ecology and sensitivity towards Environment.

Unit: 1 **14 Lectures**

The Environment: Physical environment, biotic environment, biotic and abiotic interactions. Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning and character displacement.

Unit: 2 **14 Lectures**

Ecosystem: Structure and function, energy flow and mineral cycling (CNP), primary production and decomposition, structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Types, mechanisms, changes involved in succession, concept of climax. Nature of communities, community structure and attributes, levels of species diversity and its measurement, edges and ecotones.

Unit: 3 **18 Lectures**

Population ecology: Characteristics of a population, population growth curves, population regulation, life history strategies (r and K selection), concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations. Types of interactions, interspecific competition, herbivory, carnivory, pollination and symbiosis.

Unit: 4 **8 Lectures**

Environmental pollution: Global environmental change, ozone depletion, biodiversity-status, monitoring and documentation, major drivers of biodiversity change, biodiversity management approaches, Carbon credit.

Suggested Reading:

1. Odum, E. and Barrett, G.W. (2005). *Fundamentals of Ecology*. Brooks Cole, USA.
2. Prasanthrajan, M and Mahendran, P.P. (2008). *A Text Book on Ecology and Environmental Science*. Agrotech, India.
3. Sharma, P.D. (2005). [Ecology and Environment](#). Rastogi Publications, Meerut, India.
4. Verma, P.S. Agarwal, V. K. (2000). *Environmental Biology: Principles of Ecology*. S. Chand, New Delhi, India.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Evolutionary and Developmental Biology
Paper Code: LBI.602
Semester: III

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student understands Evolutionary and Development Biology.

Unit: 1 **20 Lectures**

Emergence of evolutionary thoughts & Origin of life: Lamarckism, Darwinism, Concepts of variation, adaptation, struggle, Mendelism, Spontaneity of mutations, Theories of phyletic gradualism vs. punctuated equilibria, Modern evolutionary synthesis. Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane, Experiment of Miller (1953), The first cell, Evolution of prokaryotes, Origin of eukaryotic cells, Evolution of unicellular eukaryotes, Anaerobic metabolism, Photosynthesis and aerobic metabolism.

Unit: 2 **16 Lectures**

Paleontology and molecular evolution: The evolutionary time scale, Eras, periods and epoch, Major events in the evolutionary time scale, Origins of unicellular and multicellular organisms, Stages in primate evolution including *Homo sapiens*. Concepts of neutral evolution, Molecular divergence and molecular clocks, Molecular tools in phylogeny, Classification and identification; Origin of new genes and proteins; Gene duplication and divergence.

Unit: 3 **18 Lectures**

Basic concepts of development: Totipotency, Commitment, Specification, Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages, Stem cells, Genomic equivalence and the cytoplasmic determinants, Imprinting, Mutants and transgenics in analysis of development.

Unit: 4 **18 Lectures**

Gametogenesis, fertilization and cell death: Production of gametes, Cell surface molecules in sperm-egg recognition in animals; Embryo-sac development and double fertilization in plants, Zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, Embryogenesis and establishment of symmetry in plants, Seed formation. Hypersensitive response, functions, relevance with diseases, apoptosis, Caspases, Importance of PCD in plant development, role of PCD, model of PCD.

Suggested Reading:

1. Darwin, C.R. (1911). *On the origin of species by means of natural Selection, or preservation of favoured races in the struggle for life*. Hurst Publishers, UK.
2. Dawkins, R. (1996). *The Blind Watchmaker*, W.W. Norton & Company Jones and Bartlett Publishers.
3. Futuyma, D.J. (2009). *Evolution*. Sinauer Associates Inc. USA.
4. Hake, S. and Wilt, F. (2003). *Principles of Developmental Biology*. W.W. Norton & Company, New York, USA.
5. Hall, B.K. and Hallgrímsson, B. (2007). *Strickberger's Evolution*. Jones and Bartlett Publishers, India.
6. Lewin, R. (2004). *Human Evolution - An Illustrated Introduction*. Wiley-Blackwell, USA.
7. Scott, F. and Gilbert, S.F. (2010). *Developmental Biology*. Sinauer Associates, Inc. USA.
8. Slack, J.M.W. (2005). *Essential Developmental Biology*, Wiley-Blackwell, USA.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Microbiology
Paper Code: 603
Semester: III

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student understands Microbiology

Unit: 1 **16 Lectures**

Prokaryotic, Eukaryotic structure and function: Cell structure and function, Classifications. Bacteria, Fungi, Protozoa, Algae, and viruses, Structure of major viruses, and Viral replication.

Unit: 2 **16 Lectures**

Growth, nutrition & control: Phases in bacterial growth, Growth Curve, Calculation of G-time, Physical and environmental requirements of growth, Microbial nutritional requirements, Types of culture media. Physical and Chemical methods, Antimicrobial drugs, Antibiotic assays, Drug resistance in bacteria.

Unit: 3 **6 Lectures**

Microbial Genetics: DNA replication, Transcription and translation, Operon, Horizontal Gene Transfer.

Unit: 4 **16 Lectures**

Applied Microbiology: Environmental microbiology, Microbial ecology, Aquatic Microbiology, Food, Dairy and Agricultural Microbiology, Industrial Microbiology. Major bacterial diseases of animals and plants, Airborne, Food-borne, Soil-borne, Nosocomial and Sexually Transmitted/Contagious Diseases, Principles of disease and epidemiology, Host-Microbe relationship, Viral pathogenesis, Major viral diseases of plants and animals. Avian Influenza A/H5N1, A/H1N1 Swine Influenza, SARS, AIDS, Japanese encephalitis, Malaria and Tuberculosis, West Nile, Mechanisms of emergence and reemergence.

Suggested Reading:

1. Bauman, R.W. (2011). *Microbiology with Diseases by Body System*. Benjamin Cummings, USA.
2. Capuccino, J.G. and Sherman, N. (2004). *Microbiology-A Laboratory Manual*. Benjamin Cummings, USA.
3. Pelczar, M. J., Chan, E.C.S. and Krieg, N.R. (1993). *Microbiology: Concepts and Applications*. McGraw-Hill Inc. USA.
4. Pommerville, J.C. (2010). *Alcarno's Fundamentals of Microbiology*. Jones & Bartlett Publishers, USA.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. (2004). *Microbiology*. McGraw-Hill Science, USA.
6. Strelkauskas, A., Strelkauskas, J. and Moszyk-Strelkauskas, D. (2009). *Microbiology: A Clinical Approach*. Garland Science, New York, USA.
7. Tortora, G.J., Funke, B.R. and Case, C.L. (2009). *Microbiology: An Introduction*. Benjamin Cummings, USA.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001

Centre for Computational Sciences

Course Title: Complex Algorithms in Bioinformatics

Paper Code: LBI.604

Semester: III

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective and Learning Outcomes: The objective of this subject is to inculcate the understanding about complex algorithms currently in use in Bioinformatics.

Unit 1

14Hours

TSP; Weight matrices: Sequence weighting, pseudo count correction for low counts, Gibbs sampling, and Psi-Blast

Unit 2

14Hours

Dynamic programming: Needleman-Wunsch, Smith-Waterman, and alignment heuristics; Data redundancy and homology reduction: Hobohm and other clustering algorithms

Unit 3

14Hours

Hidden Markov Models: Model construction, Viterbi decoding, and posterior decoding, and Baum Welsh HMM learning

Unit 4

14Hours

Artificial neural networks: Architectures and sequence encoding, feed-forward algorithm, and back propagation; BCO; ACO; Genetic Algorithm

Suggested Reading

1. Mastering Algorithms with Perl; Oreilly
 2. Algorithms by Robert Sedgewick
 3. Art of Computer Programming, Volume 1: Fundamental Algorithms by Donald Ervin Knuth
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CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Complex Algorithm Lab
Paper Code: LBI.605
Semester: III

L	T	P	Credits	Marks
0	0	4	2	50

Making computer programs based on the following approaches for solving Travelling sales man problem

- Bee Colony Optimization
- Ant Colony Optimization
- Genetic Algorithm

Training Artificial neural networks for pattern predictions (different types feed-forward algorithm, and back propagation)

Suggested Reading

1. Mastering Algorithms with Perl; Oreilly
 2. Algorithms by Robert Sedgewick
 3. Art of Computer Programming, Volume 1: Fundamental Algorithms by Donald Ervin Knuth
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CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Microbiology Lab
Paper Code: LBI.606
Semester: III

L	T	P	Credits	Marks
0	0	4	2	50

1. Isolation and pure culture techniques.
 2. Staining methods: Simple staining, Negative Staining, Gram Staining, Acid-Fast stain.
 3. Standard method for bacteriological water analysis: Presumptive test, confirmed test and completed test.
 4. Microbial analysis: Analysis of food/dairy products.
 5. Microbial growth studies.
- *More practicals may be added/modified from time to time depending on available faculties/facilities.

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Dissertation Part I
Paper Code: LBI.698
Semester: III

L	T	P	Credits	Marks
0	0	16	8	200

Course Objective and Learning Outcomes: The objective of dissertation part I would be to ensure that the student learns the nuances of the scientific writing. Herein the student shall have to write his synopsis including an extensive review of literature with simultaneous identification of scientifically sound (and achievable) objectives backed by a comprehensive and detailed methodology.

The Evaluation criteria shall be multifaceted as detailed below:

Total marks 200

S.No.	Criteria	Marks allotted
Theoretical work		
1.	Review of literature and Bibliography	40
2.	Identification of gaps in knowledge	20
3.	Objective formulation	20
4.	Methodology	40
5.	Presentation	40
Experimental Work		
6.	Continuous evaluation by guide	40
	Total	200

The synopsis and presentation shall be evaluated by a three membered committee consisting of

- a. COC of the department
- b. Supervisor or Co-supervisor
- c. One other faculty of department

Third Semester Over

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Semester-4												
S.No.	Paper Code	Course Title	Course Type	L	T	P	C r	% Weightage				
								a	b	c	d	e
34	LBI.607	Systems Biology	C	4	-	-	4	25	25	25	25	100
35	LBI.608	Molecular Evolution	C	4	-	-	4	25	25	25	25	100
38	LBI.699	Dissertation		-	-	32	1 6	-	-	-	-	400
		Total Sem-4		6	0	32	2 4					600

- a. Continuous Assessment: Based on Objective Type Tests
- b. Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
- c. Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)
- d. End-Term Exam (Final): Based on Objective Type Tests
- e. Total Marks

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Systems Biology
Paper Code: LBI.607
Semester: IV

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective and Learning Outcomes: The objective of this subject is to ensure that a student learns about various aspects of systems biology and molecular evolution.

Unit 1

14 Hours

Transcription networks, basic concepts, Auto-regulation, a network motif, the feed forward loop network motif

Unit 2

14 Hours

Temporal programs and the global structure of transcription networks, Network motifs in developmental, signal-transduction and neuronal networks

Unit 3

14 Hours

Robustness of protein circuits, the example of bacterial chemotaxis, Robust patterning in development

Unit 4

14 Hours

Kinetic proofreading, optimal gene circuit design; Rules for gene regulation based on error minimization, Simplicity in biology

Suggested Reading

1. An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, Chapman & Hall, ISBN 1-58488-642-0.
 2. Hake, S. and Wilt, F. (2003). Principles of Developmental Biology. W.W. Norton and Company, New York, USA.
 3. Hall, B.K. and Hallgrímsson, B. (2007). Strickberger's Evolution. Jones and Bartlett Publishers, India.
 4. Lewin, R. (2004). Human Evolution - An Illustrated Introduction. Wiley-Blackwell, USA.
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CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Molecular Evolution
Paper Code: LBI.608
Semester: IV

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective and Learning Outcomes: The objective of Molecular Evolution would be to ensure that the student learns the nuances of Molecular Evolution.

Unit 1

14 Hours

Comparison of DNA sequences to calculate gene distance; Convergent and divergent evolution; Mutation Vs. Substitution-Rate of Molecular Evolution. Jukes Cantor Correction and evolutionary distance

Unit 2

14 Hours

Hardy-weinberg equilibrium – Heterozygosity, gene frequency and heterozygosity; Loss of heterozygosity-mutant alleles-theta as the measure

Unit 3

14 Hours

Molecular clock- Concepts and significance-molecular mechanisms of molecular clock- Neutral theory -gene family organization.

Unit 4

14 Hours

Paralogy and Orthology- coordination expression in evolution-genome : content, structure and evolution. Molecular evolution of recently diverged species - Databases of Molecular evolution.

Suggested Reading

1. Darwin, C.R. (1911). On the origin of species by means of natural Selection, or preservation of favoured races in the struggle for life. Hurst Publishers, UK.
 2. Dawkins, R. (1996). The Blind Watchmaker, W.W. Norton & Company Jones and Bartlett Publishers.
 3. Futuyma, D.J. (2009). Evolution. Sinauer Associates Inc. USA
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CENTRAL UNIVERSITY OF PUNJAB, BATHINDA – 151001
Centre for Computational Sciences

Course Title: Dissertation Part II
Paper Code: LBI.699
Semester: IV

L	T	P	Credits	Marks
0	0	32	16	400

Course Objective and Learning Outcomes: The objective of dissertation part II would be to ensure that the student learns the nuances of the scientific research. Herein the student shall have to carry out the experiments to achieve the objectives as mentioned in the synopsis. The data collected as a result of experiments must be meticulously analyzed in light of established scientific knowledge to arrive at cogent conclusions.

The Evaluation criteria shall be multifaceted as detailed below:

		Total marks 400
S.No.	Criteria	Marks allotted
1.	Report Writing	140
2.	Presentation and defense of research work	140
3.	Continuous evaluation of student by Guide	120
Total		400

The final presentation shall be evaluated by a three membered committee consisting of

- a. COC of the department
- b. Another teacher from department
- c. Supervisor (and Co-supervisor if applicable)

Completion of M.Sc. Life Science (Bioinformatics)
