APPENDIX I

COURSE STRUCTURE AND SYLLABUS

APPROVED BY

BOARD OF STUDIES

for

MSc Life Science (Bioinformatics)

2014-15

Central University of Punjab
Bathinda-151001

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Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

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 an engineering degree in a related stream with 55% marks from a recognized Indian or foreign university.

Dr. Kousik Giri	Dr. Pankaj Bhardwaj	Dr. Mahesh Kulharia	Prof. D.D. Singh
(Member, BOS)	**(Member, BOS)**	**(Member, BOS)**	**(Chairperson, BOS)**

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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.

Dr. Kousik Giri	Dr. Pankaj Bhardwaj	Dr. Mahesh Kulharia	Prof. D.D. Singh
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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 proficient in various aspects of Bioinformatics. The students shall be 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. In addition extensive stress of logic based discipline would ensure development of scientific temperament among the students. Therefore graduated students of MSc Life Science (Bioinformatics) would be 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	L	T	P	Cr	% Weightage				
							A	B	C	D	E
1	BIN.501	Research Methodology	2	-	-	2	10	15	15	10	50
2	BIN.502	Biostatistics	2	-	-	2	10	15	15	10	50
3	BIN.503	Cell Biology	3	-	-	3	15	20	20	20	75
4	BIN.504	Biochemistry	3	-	-	3	25	25	25	25	100
5	BIN.505	Genetics	3	-	-	3	25	25	25	25	100
6		Elective Course 1	4	-	-	4	25	25	25	25	100
7		Interdisciplinary Course-1	2	-	-	2	10	15	15	10	50
8	BIN.506	Biostatistics (P)	-	-	2	1	-	-	-	-	25
9	BIN.507	Cell Biology (P)	-	-	2	1	-	-	-	-	25
10	BIN.508	Biochemistry (P)	-	-	2	1	-	-	-	-	25
11	BIN.509	Genetics (P)	-	-	2	1	-	-	-	-	25
12	BIN.599	Credit Seminar			2	1	-	-	-	-	25
		Total Sem-1	19	0	10	24	-	-	-	-	600
Opt any one course from the following Elective courses (from within the department)											
13	BIN.510	Basic Sciences for Bioinformatics	4	-	-	4	25	25	25	25	100
Interdisciplinary courses for other departments											
14	BIN.511	Bioinformatics	2	-	-	2	10	15	15	10	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

Dr. Kousik Giri **(Member, BOS)** | Dr. Pankaj Bhardwaj **(Member, BOS)** | Dr. Mahesh Kulharia **(Member, BOS)** | Prof. D.D. Singh **(Chairperson, BOS)**

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Semester 2											
							% Weightage				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr**	**A**	**B**	**C**	**D**	**E**
14	BIN.512	Systems Physiology	3	-	-	3	15	20	20	20	75
15	BIN.513	Immunology	2	-	-	2	10	15	15	10	50
16	BIN.514	Sequence Analysis	4	-	-	4	25	25	25	25	100
17	BIN.515	Molecular Biology	3	-	-	3	15	20	20	20	75
18	BIN.516	Molecular Modeling and Dynamics	4	-	-	4	25	25	25	25	100
19		Elective Course-2	2	-	-	2	10	15	15	10	50
20		Interdisciplinary course-2	2	-	-	2	10	15	15	10	50
21	BIN.517	Molecular Biology (P)	-	-	2	1	-	-	-	-	25
22	BIN.518	Molecular Modeling and Dynamics (P)	-	-	4	2	-	-	-	-	50
23	BIN.519	Elective Course-2 (P)	-	-	2	1	-	-	-	-	25
		Total Sem-2	20	0	8	24					600
Opt any one course from the following Elective courses (from within the department)											
25	BIN.520	Database Management Systems	2	-	-	2	10	15	15	10	50
Interdisciplinary course for other departments											
26	BIN.521	Molecular Phylogenetics	2	-	-	2	10	15	15	10	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

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Semester-3												
S.No.	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr**	**% Weightage**				
							A	**B**	**C**	**D**	**E**
27	BIN.601	Ecology and Environment	3	-	-	3	25	25	25	25	75
28	BIN.602	Evolutionary and Developmental Biology	3	-	-	3	25	25	25	25	75
29	BIN.603	Microbiology	3	-	-	3	25	25	25	25	50
30	BIN.604	Complex Algorithms in Bioinformatics	3	-	-	3	25	25	25	25	100
31	BIN.605	Complex Algorithm in Bioinformatics (P)	-	-	4	2	-	-	-	-	50
32	BIN.606	Microbiology (P)	-	-	4	2	-	-	-	-	50
33	BIN.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

L: Lectures T: Tutorial P: Practical Cr: Credits

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Semester-4											
S.No.	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr**	**% Weightage**				
							A	**B**	**C**	**D**	**E**
34	BIN.607	Systems Biology	4	-	-	4	25	25	25	25	100
35	BIN.608	Molecular Evolution	4	-	-	4	25	25	25	25	100
38	BIN.699	Dissertation	-	-	32	16	-	-	-	-	400
		Total Sem-4	6	0	32	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
L: Lectures T: Tutorial P: Practical Cr: Credits

Dr. Kousik Giri	Dr. Pankaj Bhardwaj	Dr. Mahesh Kulharia	Prof. D.D. Singh
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Course Title: Research Methodology
Paper Code: BIN.501
Semester: I

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective: 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 **5 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 **10 Lectures**

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

Unit 3 **5 Lectures**

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

Unit 4 **16 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. Standard /Reputed Journal authors' instructions.

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School of Emerging Life Science Technologies
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Course Title: Biostatistics
Paper Code: BIN.502
Semester: I

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective: 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, Univariant and multivariant 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 **14Lectures**

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

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Course Title: Cell Biology
Paper Code: BIN.503
Semester: I

L	T	P	Credits	Marks
3	0	0	3	75

Objective: 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 secretary 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,

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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., Lews, 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.

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Course Title: Biochemistry
Paper Code: BIN.504
Semester: I

L	T	P	Credits	Marks
3	0	0	3	100

Objective: 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. (2008). *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. (2008). *Principles of biochemistry*. CBS Publishers & Distributors. New Delhi, India.

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Course Title: Genetics
Paper Code: BIN.505
Semester: I

L	T	P	Credits	Marks
3	0	0	3	100

Objective: 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:

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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.

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Course Title: Basic Sciences for Bioinformatics
Paper Code: BIN.510
Semester: I

L	T	P	Credits	Marks
4	0	0	4	100

Objectives: 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. 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. Physics by Resnick and Halliday
2. Mathematics by R.S. Agrawal
3. Organic chemistry by Morrison and Boyd
4. Physical Chemistry by A. J. Mee
5. by F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann

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School of Emerging Life Science Technologies
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Course Title: Bioinformatics
Paper Code: BIN.511
Semester: I

L	T	P	Credits	Marks
2	0	0	2	50

For other departments only

Objectives: This course shall act as bridge course for the students of biology back-ground and is designed to brush-up their knwoledge on fundamentals of Chemistry, Physics and Mathematics. 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. Physics by Resnick and Halliday
2. Mathematics by R.S. Agrawal
3. Organic chemistry by Morrison and Boyd
4. Physical Chemistry by A. J. Mee
5. by F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann

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Course Title: Biostatistics (Practical)
Paper Code: BIN.506
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.

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Course Title: Cell Biology (Practical)
Paper Code: BIN.507
Semester: I

L	T	P	Credits	Marks
0	0	2	1	25

1. Preparation of mitotic & meiotic chromosomes.
2. Study of structure of cell organelles through electron micrographs.
3. Instrumental methods for cell biology-centrifugation, chromatography.
4. Bacterial staining and identification.
5. Sectioning of tissues (Plant and animal).
6. Histochemical techniques (Fixing, Processing, Staining).

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

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Course Title: Biochemistry (Practical)
Paper Code: BIN.508
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.

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Course Title: Genetics (Practical)
Paper Code: BIN.509
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 dermatogylphics 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.

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School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Credit Seminar
Paper Code: BIN.599
Semester: I

L	T	P	Credits	Marks
0	0	2	1	25

Objective: The objective of dissertation part I 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

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

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.

Objectives: 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

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Systems Physiology
Paper Code: BIN.512
Semester: II

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective: The objective of this subject is to ensure that a student learns various aspects of animal and plant physiology.

Unit 1 **14 Hours**
Plant Physiology I: Photosynthesis, Nitrogen metabolism, Plant hormones

Unit 2 **14 Hours**
Plant Physiology II: Sensory photobiology, Solute transport and photoassimilate translocation, Stress physiology

Unit 3 **14 Hours**
Animal Physiology I: Blood and circulation; Cardiovascular System; Respiratory system; Nervous system;

Unit 4 **14 Hours**
Animal Physiology II: Sense organs; Excretory system; Thermoregulation; Stress and adaptation; Digestive system; Endocrinology and reproduction;

Suggested Reading

1. Plant Physiology by Salisbury and Ross
2. Animal Physiology by Gerhard J. Tortora
3. Devlin, T.M. (2005). *Textbook of Biochemistry with clinical correlations*. John Wiley & Sons Inc. USA.
4. Guyton. (2007). *Textbook of medical physiology*. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
5. Hill, R.W, Wyse, G. A. and Anderson, M. (2008). *Animal physiology*. Sinauer Associates Inc. USA.
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

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Immunology
Paper Code: BIN.513
Semester: II

L	T	P	Credits	Marks
2	0	0	2	50

Objective: 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 10 Lectures

Immune system: Recognition of self and nonself, Humoral immunity-immunoglogulins, 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 16 Lectures

Complement system and major histocompatibility system: Complement components, their structure and functions and mechanisms of complement activation by classical, alternative and lectin pathway. Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution variation and function. Association of MHC with disease and superantigen, recognition of antigens by T and B-cells, antigen processing, role of MHC molecules in antigen presentation and co stimulatory signals, tumor immunology

Unit: 3 12 Lectures

Hypersensitivity: Types, features and mechanisms of immediate and delayed hypersensitivity reactions, immunity to microbes, immunity to tumors, AIDS and immunodeficiencies, hybridoma technology and vaccine, natural, synthetic and genetic, development of vaccine for diseases like AIDS, cancer and malaria.

Unit: 4 14 Lectures

Monoclonal antibodies and Diagnostic immunology: Production, characterization and applications in diagnosis, therapy and basic research, immunotoxins, concept of making immunotoxins. Methods for immunoglobulin determination-quantitative and qualitative antigen and antibody reactions, agglutination-precipitation, immunoflourescence, immunoblotting and assessment of human allergic diseases.

Suggested Reading:

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

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

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Sequence Analysis
Paper Code: BIN.514
Semester: II

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: 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 Phylogency, Definition and description of phylogenetic trees and various types of trees.

Suggested Reading:

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

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

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Molecular Biology
Paper Code: BIN.515
Semester: II

L	T	P	Credits	Marks
3	0	0	3	75

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.

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Molecular Modeling and Dynamics
Paper Code: BIN.516
Semester: II

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: 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 univariative, 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.

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Database Management System
Paper Code: BIN.520
Semester: II

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective: 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 architexture 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 algorthim statisca 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.

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Molecular Biology (Practicals)
Paper Code: BIN.517
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.

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Molecular Modeling and Dynamics
Paper Code: BIN.518
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.

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Database Management System Lab
Paper Code: BIN.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.

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Molecular Phylogenetics

(Inter disciplinary for other departments)

L	T	P	Credits	Marks
2	0	0	2	50

Paper Code: BIN.521
Semester: II

Course Objective: 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 phylogentic 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

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

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

Objectives: 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

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Ecology and Environment
Paper Code: BIN.601
Semester: III

L	T	P	Credits	Marks
3	0	0	3	75

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, interdemic 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.

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

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

L	T	P	Credits	Marks
3	0	0	3	75

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 Hallgrimsson, 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.

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Microbiology
Paper Code: 603
Semester: III

L	T	P	Credits	Marks
2	0	0	2	50

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). *Alcamo'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.
8.

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Complex Algorithms in Bioinformatics
Paper Code: BIN.604
Semester: III

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: 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

Centre for Bioinformatics

School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Complex Algorithm Lab
Paper Code: BIN.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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School of Emerging Life Science Technologies
Central University of Punjab

Course Title: Microbiology Lab
Paper Code: BIN.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.

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Central University of Punjab

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

L	T	P	Credits	Marks
0	0	20	10	150

Objective: 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 alloted
	Theoretical work	
1.	Review of literature	40
2.	Identification of gaps in knowledge	40
3.	Objective formulation	20
4.	Methodology	40
5.	References	20
	Experimental Work	
6.	Continuous evaluation by guide	40
	Total	200

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

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

Third Semester Over

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Central University of Punjab

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

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: 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 Hallgrimsson, 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

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

L	T	P	Credits	Marks
4	0	0	4	100

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

L	T	P	Credits	Marks
0	0	32	16	400

Objective: 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 350

S.No.	Criteria	Marks allotted
1.	Report Writing	150
2.	Presentation and defense of research work	100
3.	Continuous evaluation of student by Guide	100
	Total	350

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

a. COC of the department
b. External Expert
c. Supervisor (and Co-supervisor if applicable)

Completion of MSc Life Science (Bioinformatics)
