FACULTY OF SCIENCE

SYLLABI

FOR

BIOINFORMATICS
(ELECTIVE)
1\textsuperscript{st} & 2\textsuperscript{nd} Year (Semester System)
&
3\textsuperscript{rd} Year (Annual System)

EXAMINATIONS, 2015-2016

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<table>
<thead>
<tr>
<th>Paper Code</th>
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<tbody>
<tr>
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<tr>
<td>BNE 1001</td>
<td>I</td>
<td>Introduction to Bioinformatics</td>
<td>4</td>
<td>75(67+8)</td>
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<tr>
<td>BNE 1002</td>
<td>II</td>
<td>Cell Biology &amp; Biochemistry</td>
<td>4</td>
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<tr>
<td>BNEP 1051</td>
<td>Practical</td>
<td>Introduction to Bioinformatics</td>
<td>3</td>
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<tr>
<td>BNEP 1052</td>
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<td>Cell Biology &amp; Biochemistry</td>
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<tr>
<td>BNE 2001</td>
<td>III</td>
<td>Statistics and Computer Fundamentals</td>
<td>4</td>
<td>75(67+8)</td>
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<tr>
<td>BNE 2002</td>
<td>IV</td>
<td>Microbiology &amp; Genetics</td>
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<tr>
<td>BNEP 2051</td>
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<td>25(20+5)</td>
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</table>


Objective
This course will give exposure to the students to study Biomolecules and its integration in information technology.

Instructions for the paper-setters and Candidates

Note: A
1. Nine questions will be set in all, uniformly distributed over the entire syllabus i.e. four questions from each unit and one compulsory question.
2. Q. No. 1 will be of objective type of 15 Marks (containing 10 parts of 1 ½ marks each) covering the entire syllabus.
3. The candidates will be required to attempt five questions in all by selecting two questions from each unit and the first compulsory question.
4. The questions (2-9) may be divided into at least two parts and each question (2-9) will carry 13 marks.

Note: B
External System of examination will be followed.

UNIT I

Introduction to Genes and Genome Sequences:
Nucleic acids: double helix, melting temperatures, closed circular DNA and supercoiling
Open Reading Frames (ORFs), Detecting ORFs. Concepts of Introns, Exons, Splice Variants, Triplet Coding.
Amino acids and their properties. Introduction to Proteins, Protein Structure: Secondary, Tertiary, Quaternary. The notion of Homology as evolutionary relatedness. Similarity and Identity of sequences.

UNIT II

Sequence databases:
Primary and secondary databases. Nucleotide sequence databases, nucleotide sequence flat files.
Functional divisions in sequence databases.
Protein sequence databases: Genpept, Uniprot, Swissprot, PIR. Sequence formats: Genbank, FASTA, ASN.
Information retrieval for biological databases. The NCBI resource. Entrez, Pubmed, Medline. Entrez Boolean search terms and statements, NCBI bookshelf

BNEP 1051 PRACTICAL: Introduction to Bioinformatics
Max. Marks : 25 (20+5)

1. Retrieval of DNA sequences from Entrez databases
2. Retrieval of protein sequences
3. Retrieval of sequences in different sequence formats
4. Searching for publications in Pubmed by different criteria

**Recommended Books:**


**BNE 1002  CELL BIOLOGY & BIOCHEMISTRY**

Max Marks: 75  
Theory :  67  
Int. Ass. :  08

**Objective**

*The students are exposed to the underline concepts and phenomenon of cell Biology and Chemistry of Biomolecules.*

**Instructions for the paper-setters and Candidates**

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**Note: B**  
External System of examination will be followed.

**UNIT I**

**Basic Cell Biology:**

Cell as a basic unit of living systems: The cell theory, Pre-cellular evolution: artificial creation of “cells”.

UNIT II

**Basic Biochemistry:**
General properties of organic and inorganic compounds. Solubility of organic compounds for generation of structure, storage of energy and information.
Structure and functions of Biomolecules- Carbohydrates, Proteins, Lipids, Nucleic Acids
Enzymes- Classification, Nomenclature, general properties, regulation of enzyme activity, steady state kinetics. Applications in industries – Enzymes in food processing, medicine, diagnostics and production of new compounds. Enzymes as research tools – ELISA methods, enzymes.

**BNEP 1052 PRACTICAL : Cell Biology & Biochemistry**

MAX. MARKS : 25 (20+5)

1. Estimation of Sugars
2. Estimation of proteins by Lowry’s method
3. Estimation of DNA/RNA
4. Estimation of enzyme activity

**Recommended Books:**

SEMESTER - II

BNE 2001  STATISTICS AND COMPUTER FUNDAMENTALS

Max Marks: 75
Theory : 67
Int. Ass. : 08

Objective
To introduce basics of computer fundamentals including components of hardware, software and various algorithms. Also students will be making aware of basics statistical techniques used in Bioinformatics.

Instructions for the paper-setters and Candidates

Note: A

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Note: B     External System of examination will be followed.

UNIT I

General introduction to computers:
Organization of computers, digital and analogue computers, computer algorithms. Various devices, memory and application.
Milestones in hardware and software – batch oriented / online/realtime applications
Computers as a system: Basic concepts, stored programs, functional units, and their interrelation: communications with computer.
Data storage devices primary storage: storage addressed and capacity, type of Memory:

UNIT II

Role of statistics in bioinformatics:
Fundamentals of statistics: Data types, collection and representation of data, measurement scales (nominal, ordinal, interval and ratio). Mean, median, mode, measures of dispersion, measures of skewness and kurtosis, Graphical methods-Histogram, Bar, Pie, Box and whisker plot.
Probability definition, addition and multiplication theorems, Baye’s Theorem (Probability Problems based on these Theorems)
BNEP 2051 PRACTICAL: Statistics and Computer Fundamentals

MAX. MARKS : 25 (20+5)

1. Flow Charts
2. Various algorithms and function used in programming
3. Measures of central tendency
4. Measures of Dispersion
5. Graphical Methods- Histogram, Bar, Pie, Box and whisker plot
6. Problem related to probability and conditional probability

Recommended Books:

1. Computer fundamentals by PK Sinha 2011
2. RG Dromey “How to solve it by computer” Seventh Edition 2001, Prentice Hall of India
5. Biostatistics (1996) PN Arora and PK Malhotra Himalaya Publishing House,

BNE 2002 MICROBIOLOGY & GENETICS

Max Marks: 75
Theory : 67
Int. Ass. : 08

Objective
This course will help students to acknowledge the phenomenon which result in gene diversity, evolution and microbial diversity.

Instructions for the paper-setters and Candidates

Note: A

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Note: B External System of examination will be followed.

UNIT I

Introduction to Genetics:
Chromosomes structure and functions; Chromosome banding.
Mutagenesis in bacteria- types of mutants, mutagenic agents, isolation and characterization of mutants, reversion, suppression, transposable elements

UNIT II

Microbiology:

BNEP 2052 PRACTICAL: Microbiology and Genetics
Max. Marks : 25 (20+5)

1. Experiments on isolation of microbes
2. Spread plates, pour plates
3. Staining simple, differential, Gram

Recommended Books:
## SEMESTER - III

<table>
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<tr>
<th>Paper Code</th>
<th>Paper</th>
<th>Name of the Paper</th>
<th>Lectures / week</th>
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<td>V</td>
<td>Sequence Analysis</td>
<td>4</td>
<td>75(67+8)</td>
<td>200</td>
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<tr>
<td>BNE 3002</td>
<td>VI</td>
<td>Fundamentals of Molecular Biology-I</td>
<td>4</td>
<td>75(67+8)</td>
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<tr>
<td>BNEP 3051</td>
<td>Practical</td>
<td>Sequence Analysis</td>
<td>3</td>
<td>25(20+5)</td>
<td></td>
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<tr>
<td>BNEP 3052</td>
<td>Practical</td>
<td>Fundamentals of Molecular Biology-I</td>
<td>3</td>
<td>25(20+5)</td>
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## SEMESTER - IV

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<th>Lectures / week</th>
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<th>Total Marks</th>
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<tr>
<td>BNE 4001</td>
<td>VII</td>
<td>Structure Analysis</td>
<td>4</td>
<td>75(67+8)</td>
<td>200</td>
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<tr>
<td>BNE 4002</td>
<td>VIII</td>
<td>Fundamentals of Molecular Biology-II</td>
<td>4</td>
<td>75(67+8)</td>
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<td>BNEP 4051</td>
<td>Practical</td>
<td>Structure Analysis</td>
<td>3</td>
<td>25(20+5)</td>
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<tr>
<td>BNEP 4052</td>
<td>Practical</td>
<td>Fundamentals of Molecular Biology-II</td>
<td>3</td>
<td>25(20+5)</td>
<td></td>
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</table>
Objective
In this paper, sequence and phylogenetic analysis of proteins and nucleotides using various computational tools which are important to study conservation in different species is covered.

Instructions for the paper-setters and Candidates

Note: A

5. Nine questions will be set in all, uniformly distributed over the entire syllabus i.e. four questions from each unit and one compulsory question.
6. Q. No. 1 will be of objective type of 15 Marks (containing 10 parts of 1 ½ marks each) covering the entire syllabus.
7. The candidates will be required to attempt five questions in all by selecting two questions from each unit and the first compulsory question.
8. The questions (2-9) may be divided into at least two parts and each question (2-9) will carry 13 marks.

Note: B　External System of examination will be followed.

UNIT I

Pairwise sequence alignment
Global alignment, Local alignment
Scoring functions, General gap and affine gap penalty
BLAST algorithm
Significance of alignments: E value, Scores.

Multiple sequence alignment
SP (Sum of Pairs) measure,
Clustal W, Clustal X,

UNIT II


Phylogenetic analysis:
Distance and parsimony methods; Clustering methods.
Rooted and unrooted trees, Bootstrapping, Phylip.
BNEP 3051 SEQUENCE ANALYSIS (PRACTICAL)

Max. Marks : 25 (20+5)

1. Aligning 2 DNA sequences
2. Aligning 2 protein sequences
3. Multiple sequence alignment using Clustal X
4. BLASTp and BLASTn searches and interpretation of results

Recommended Books:
5. Computer fundamentals by PK Sinha
6. RG Dromey “How to solve it by computer” Seventh Edition 2001, Prentice Hall of India

BNE 3002 FUNDAMENTALS OF MOLECULAR BIOLOGY-I

Max Marks: 75
Theory : 67
Int. Ass. : 08

Instructions for the paper-setters and Candidates

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Note: B External System of examination will be followed.

Objective
In this paper Contents are related to the fundamental of molecular biology so that the students are exposed to underlying phenomenon.
UNIT I
Structure of prokaryotic and eukaryotic genes.

DNA replication:
Both prokaryotes and eukaryotes
Properties of DNA polymerases, Synthesis of Leading and lagging strands
DNA Repair: Photo-reactivation, excision repair, post replication repair, SOS repair.

UNIT II

Transcription
RNA polymerase in prokaryotes – its molecular composition, role of each component of
RNA polymerase, mechanism of transcription,

Gene Expression
Prokaryotic gene expression. Lac, His, Trp operons. Catabolite repression
Eukaryotic gene expression and transcription factors

BNEP 3052 FUNDAMENTALS OF MOLECULAR BIOLOGY-I (PRACTICAL)
Max. Marks : 25 (20+5)

5. Isolation of DNA from cells
6. Isolation and purification of proteins
7. Chromatographic methods for separation of amino acids, lipids

Recommended Books:
5. D.S.T. Nitcholl, An Introduction to genetic engineering, Cambridge Univ. Press,
   1996.
Objective  
*In this paper, sequence analysis of proteins and nucleotides using various computational tools which are important to study conservation in different species is covered.*

Instructions for the paper-setters and Candidates

**Note: A**

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**Note: B**  
External System of examination will be followed.

**UNIT-I**  
**Protein Structure Prediction**
Secondary structure prediction methods: CHAU FASMAN, GOR, Neural Network  
Tertiary Structure prediction methods- Homology Modeling, Threading/Fold recognition and Ab initio methods.

**UNIT-II**

**Gene prediction methods:** searching by signal, searching by content, homology based predictions, Markov models, Hidden Markov models in gene prediction.  
Gene prediction tools: Genscan, Glimmer, Grail.  
Promoter analysis and predictions for prokaryotic and eukaryotic Genomes  
RNA structure prediction.

**BNEP 4051 STRUCTURE ANALYSIS (PRACTICAL)**  
Max. Marks : 25 (20+5)

1. GenScan  
2. Glimmer  
3. SPDB viewer  
4. Modeller
Recommended Books:
5. Computer fundamentals by PK Sinha
6. RG Dromey “How to solve it by computer” Seventh Edition 2001, Prentice Hall of India

BNE 4002  FUNDAMENTALS OF MOLECULAR BIOLOGY-II

Max Marks: 75
Theory : 67
Int. Ass. : 08

Objective
In this paper Contents are related to the fundamental of molecular biology so that the students are exposed to underlying phenomenon and their applications.

Instructions for the paper-setters and Candidates

Note: A

1. Nine questions will be set in all, uniformly distributed over the entire syllabus i.e. four questions from each unit and one compulsory question.
2. Q. No. 1 will be of objective type of 15 Marks (containing 10 parts of 1 ½ marks each) covering the entire syllabus.
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4. The questions (2-9) may be divided into atleast two parts and each question (2-9) will carry 13 marks.

Note: B  External System of examination will be followed.

UNIT-I

Translation:
The genetic code. Prokaryotic and Eukaryotic Translation
Modification of RNA : 5’ – CAP formation, 3 – end processing polyadenylation, Splicing,
Nuclear export of mRNA & mRNA stability
UNIT-II

Introduction: History and scope of recombinant DNA technology. Gene cloning and need to clone a gene. Modifying enzymes: Restriction endonuclease, exonucleases, ligases, polymerases, kinase, alkaline phosphatase, topoisomerase etc.
Purification of DNA from bacterial, plant and animal cells.

Mutations:
Types: Transitions, Transversions. Forward and Reversion mutations. Missense and Nonsense mutations. Chemical and physical mutagens. Induced mutations in plants, animals, and microbes and their importance.

BNEP 4052  FUNDAMENTALS OF MOLECULAR BIOLOGY-II (PRACTICAL)

Max. Marks: 25 (20+5)

1. Estimation of DNA/RNA
2. Isolation and purification of proteins
3. Isolation of mutants in E.coli resistant to ampicillin

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SYLLABUS FOR B.Sc. BIOINFORMATICS (ELECTIVE) COURSE
SESSION 2015-2016
B.Sc –3rd Year

BNE 3001 INTRODUCTION TO GENOMICS AND PROTEOMICS

Max Marks: 75
Theory : 67
Int. Ass. : 08

Instructions for the paper-setters and Candidates

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Note: B External System of examination will be followed..

UNIT I


UNIT II

DNA sequencing methods: manual and automated methods. Chain termination method; DNA sequencing by Capillary electropherisis. Basecalling and sequence accuracy. Polymorphisms, Repeats and Single Nucleotide Polymorphisms (SNPs)

UNIT III

Proteins: Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions: Electrostatic forces, Van der Waal interactions, Hydrogen bonds, Ionic bonds, Hydrophobic bonds. Proteins: Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE.

UNIT IV

1. Detecting Open Reading Frames in sequences
2. Repeat searches
3. ORF Finder at NCBI: The ORF Finder (Open Reading Frame Finder)
4. Software for Gene identifications on the web
5. PAGE
6. Proteomics 2D databases
7. Proteome Database

Recommended Books:

UNIT I

Introduction: History and scope of recombinant DNA technology. Gene cloning and need to clone a gene. Modifying enzymes: Restriction endonuclease, exonucleases, ligases, polymerases, kinase, alkaline phosphatase, topoisomerase etc. Purification of DNA from bacterial, plant and animal cells. Cloning and expression vectors: for E.coli, yeast, plants (agrobacterium) and animal viruses.
UNIT II


UNIT III

Immunology
Basic Immunology: Type of immunity- innate, acquired, active and passive.
Cells and tissues of immune systems: Lymphoid cells, mononuclear cells, dendritic cells, lymphoid organs.
Primary and secondary antigens: Immunogenicity, chemical composition, immunogen dosage, Haptens, adjuvants,. Antibody structure, functions and types of –antibody diversity, Ig domains
Ag-Ab interactions- cross reactions, precipitation and agglutination.

UNIT IV

Major histocompatibility complex (MHC), MHC restriction, regulation. Antigen presentation and processing antigen presenting cells, cell mediate subset of T-cells: helper and suppressor cells.
Immunological techniques: Immunodiffusion, Immunlecetrophoresis
Stem cell biology

BNEP 3052 PRACTICAL: Introduction to Genetic Engineering and Immunology
Max. Marks : 25 (20+5)

1. Preparation of normal serum and plasma
2. ELISA
3. To determine the WBC/RBC Count
4. Radial immunodiffusion analysis
5. Diagnosis of an infectious disease by an immuno assay
6. Agglutination reaction
7. Isolation of chromosomal and plasmid DNA from bacteria
8. Restriction digestion of DNA
9. Cytological Preparations
10. Fixation, dehydration and staining
11. Embedding and sectionings
12. Cell counting methods
13. Agarose gel electrophoresis

Recommended Books:


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