FACULTY OF SCIENCE

SYLLABI

FOR

BIOINFORMATICS
ADD-ON COURSE

EXAMINATIONS, 2015

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### SYLLABUS FOR B.Sc. BIOINFORMATICS (ADD-ON COURSE)

**SESSION 2014-2015**

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Paper</th>
<th>Name of the Paper</th>
<th>Lectures / week</th>
<th>Max Marks</th>
<th>Total Marks</th>
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<tbody>
<tr>
<td><strong>B.Sc. 1st Year</strong></td>
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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>
<td>200</td>
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<tr>
<td>BNE 1002</td>
<td>II</td>
<td>Foundations of Modern Biology</td>
<td>4</td>
<td>75(67+8)</td>
<td>200</td>
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<td>BNEP 1051</td>
<td>Practical</td>
<td>Introduction to Bioinformatics</td>
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<td>BNEP 1052</td>
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<td>3</td>
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<td><strong>B.Sc. 2nd Year</strong></td>
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<tr>
<td>BNE 2001</td>
<td>III</td>
<td>Biomolecular Sequence analysis and introduction to programming</td>
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<td>75(67+8)</td>
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<td>BNE 2002</td>
<td>IV</td>
<td>Fundamentals of Molecular Biology</td>
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<td>75(67+8)</td>
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<td>BNEP 2051</td>
<td>Practical</td>
<td>Biomolecular Sequence analysis and introduction to programming</td>
<td>3</td>
<td>25(20+5)</td>
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<td>BNEP 2052</td>
<td>Practical</td>
<td>Fundamentals of Molecular Biology</td>
<td>3</td>
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<td>BNE 3001</td>
<td>V</td>
<td>Introduction to Genomics and Proteomics</td>
<td>4</td>
<td>75(67+8)</td>
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<td>BNE 3002</td>
<td>VI</td>
<td>Introduction to Genetic Engineering and Immunotechnology</td>
<td>4</td>
<td>75(67+8)</td>
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<td>BNEP 3051</td>
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<td>BNEP 3052</td>
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<td>Introduction to Genetic Engineering and Immunotechnology</td>
<td>3</td>
<td>25(20+5)</td>
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</tbody>
</table>

* No Internal Assessment for Add-on Course
B.Sc –I Year

BNE 1001  INTRODUCTION TO BIOINFORMATICS

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. two from each unit.
2. Q. No. 1 will be of objective type (containing 10 parts of 1½ marks each) covering the entire syllabus will be compulsory.
3. The candidates will be required to attempt five questions in all by selecting at least one question from each unit.
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. Locuslink, NCBI bookshelf

UNIT III

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:
Secondary storage devices: Magnetic tape – data representation and R/W: Magnetic
disks, fixed and removable, data representation and R/W : Floppy and Hard disks, Optical disks, CD-ROM, Mass storage devices.

UNIT IV

Role of statistics in bioinformatics:
Fundamentals of statistics: Data types, collection and representation of data. Mean, median, mode, measures of dispersion. Probability definition, addition and multiplication theorems, Baye’s Theorem

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:

5. Biostatistics (1996) PN Arora and PK Malhotra Himalaya Publishing House,
6. Introduction to Biostatistics (1973) Sokal & Rohif – Toppan Co Japan

BNE 1002 FOUNDATIONS OF MODERN BIOLOGY

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

Basic Cell Biology:
Cell as a basic unit of living systems: The cell theory, Precellular evolution: artificial creation of “cells”.
Introduction for structure and function of cell organelles: Ultra structure of cell membrane, cytosol, golgi bodies, endoplasmic reticulum (rough and smooth), ribosomes, cytoskeletal structures (actin, microtubules etc.), mitochondria, chloroplasts, lysosomes, peroxisomes, vacuoles. Nucleus, nuclear membrane, nucleoplasm, nucleolus, chromatin, Cell motility (amoeboid, flagellar, and ciliar)
Cell senescence and death. Cell division and cell cycle.

UNIT II

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

UNIT III

Microbiology:
Classification of microbes. Taxonomy, Current methods of microbial identification, characteristic features of Eubacteria, Archaebacteria, Fungi, Algae, Protozoa, and viruses.
Nature of the microbial cell surface: Gram positive and Gram-negative bacteria, flagella, pili, cell inclusions, endospore, growth curve, microbial metabolism and growth, synchronized and continuous growth.
Nutritional classification of microorganisms: microbes in extreme environments, the theromphiles and alkalophiles. A survey of products from microorganisms.

UNIT IV

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 : Foundations of Modern biology

MAX. MARKS : 25 (20+5)

1. Experiments on isolation of microbes, Spread plates, pour plates and staining (simple, differential, gram), count of microbes (standard plate count).
2. Isolation of microorganisms from air, water and soils, samples, dilution and pour plating
3. Personal hygiene – Microbes from hands, tooth.
4. Testing of microbiological qualities of milk and water
5. Extraction and separation of lipids
6. Estimation of proteins by Lowrys method
7. Estimation of DNA/RNA
Recommended Books:

B.Sc –II year

BNE 2001 BIOMOLECULAR SEQUENCE ANALYSIS AND INTRODUCTION TO PROGRAMMING

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

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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
Statistical significance

UNIT II

Multiple sequence alignment
SP (Sum of Pairs) measure,
Clustal W, Clustal X,
BLAST algorithm
Significance of alignments: E value, Scores.

UNIT III

Phylogenetic analysis:
Distance and parsimony methods; Clustering methods.
Rooted and unrooted trees, Bootstrapping, Phylip.

UNIT IV

Introduction to Programming
Algorithms for Problem Solving
Exchanging values of two variables, summation of a set of numbers, Decimal Base to binary Base Conversion, reversing digits of an integer.
BNEP 2051 PRACTICAL: Biomolecular Sequence analysis and introduction to Programming

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 2002 FUNDAMENTALS OF MOLECULAR BIOLOGY

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

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Note: B

External System of examination will be followed.

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

**UNIT III**

**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 IV**

**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 2052  PRACTICAL: Fundamentals of molecular Biology**

Max. Marks : 25 (20+5)

1. Isolation of DNA from cells
2. Estimation of DNA/RNA
3. Isolation and purification of proteins
4. Chromatographic methods for separation of amino acids, lipids
5. Isolation of mutants in E.coli resistant to ampicillin

**Recommended Books:**

5. D.S.T. Nitcholl, An Introduction to genetic engineering, Cambridge Univ. Press,
   1996.
B.Sc –III 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

 Detection of 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:

BNE 3002 INTRODUCTION TO GENETIC ENGINEERING AND IMMUNOTECHNOLOGY

Instructions for the paper-setters and Candidates

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

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, Immunoelectrophoresis

Stem cell biology

BNEP 3051 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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