Kalinga University Atal Nagar (C.G.)

SCHEME OF EXAMINATION
& SYLLABUS

of

MSC (Bioinformatics)

UNDER

Faculty of Science

w.e.f. Session 2021-22

Kalinga University Naya Raipur
MSC. (Bioinformatics)
(MBI)
Scheme
(Effective from the Session: 2021-22)

SEMESTER -I					
Code No.	**Paper**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
MBI101	Chemistry of Biomolecules	4	30	70	100
MBI102	Cell Biology and Genetics	4	30	70	100
MBI103	Biological Databases	4	30	70	100
MBI104	Basic Mathematics and Biostatistics	4	30	70	100
GE-I	**(Any One) 105A/105B**	4	30	70	100
MBI105A	Research Methodology				
MBI105B	Science Journalism				
MBI106P	Biochemistry and Cell Biology Laboratory	2	20	30	50
MBI107P	Biological Databases Laboratory	2	20	30	50
	Total	**24**	**190**	**410**	**600**

SEMESTER -II					
Code No.	**Paper**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
MBI201	Biological Sequence Analysis	4	30	70	100
MBI202	Basic Programming	4	30	70	100
MBI203	Molecular Modeling	4	30	70	100
MBI204	Molecular Biology	4	30	70	100
GE-II	**(Any One) 205A/205B**	3	30	70	100
MBI205A	Entrepreneurship	4	30	70	100
MBI205B	Intellectual Property Rights				
MBI206P	Biological Sequence Analysis and Basic Programming Laboratory	2	20	30	50
MBI207P	Molecular Biology and Modeling Laboratory	2	20	30	50
	Total	**24**	**190**	**410**	**600**

SEMESTER -III					
Code No.	**Paper**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
MBI301	Genomics and Proteomics	4	30	70	100
MBI302	Omics and Systems Biology	4	30	70	100
MBI303	Advanced Programming	4	30	70	100
DSE-I	**(Any One) 304A/304B**	4	30	70	100
MBI304A	Microbiology and Immunology				
MBI304B	Genetic Engineering				
DSE-II	**(Any One) 305A/305B**	4	30	70	100
MBI305A	Cancer – Diagnosis, Therapy and Prevention				
MBI305B	Fundamentals of Bioinformatics				
MBI306P	Genomics and Proteomics Laboratory	2	20	30	50
MBI307P	Advanced Programming Laboratory	2	20	30	50
	Total	**24**	**190**	**410**	**600**
SEMESTER -IV					
Code No.	**Paper**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
MBI401	Drug Designing and Nanotechnology	4	30	70	100
DSE-III	**(Any One) 402A/402B/402C**	4	30	70	100
MBI402A	Cancer Biology and Cancer Informatics				
MBI402B	Algorithms for Biology				
MBI402C	Stem cell Biology and Regenerative Medicine				
MBI403P	Drug Designing Laboratory	2	20	30	50
MBI404P	Dissertation/Project Work	10	100	200	300
	Total	**20**	**180**	**370**	**550**

***Project Dissertation 75**
***Presentation 50**
***Viva Voce 50**
***Scientific Paper 25**

M.Sc. (BIOINFORMATICS)
I SEMESTER

(MBI101): CHEMISTRY OF BIOMOLECULES

Course Objectives

- To understand the biological roles of carbohydrates (Mono, oligo, polysaccharides) and their chemical structures.
- To learn about amino acids, proteins, naturally occurring peptides and structural organization and its conformation.
- To outline the concept of lipids, their biological and chemical roles.
- To learn in detail the structures of DNA and RNA structure, sequence determination and synthesis.
- To understand the enzymes – nomenclature, kinetics, specificity

UNIT-I

Classification and chemical properties of carbohydrates. Chemistry and biological roles of mono, di and poly (homo and hetero) saccharine, peptdiogycans, glycosaminoglycans and glycoproteins. Structural elucidation of polysaccharides (starch).

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the classification and chemical properties of carbohydrates.
- Describe the biological roles of mono, di and polysaccharides.
- Understand the structure and biological role of peptidoglycans, glycosaminoglycans and glycoproteins.
- Elucidate the structure of starch.

UNIT-II

Amino acids- classification, structure and physicochemical properties, Peptide bond.Naturally occurring peptides.Solid phase peptide synthesis. Proteins – classification, purification and criteria of homogeneity. Structural organization, Conformation of protein structure – Ramachandran plot.Sequence determination.Denaturation of proteins.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the classification, structure and properties of amino acids.
- Describe naturally occurring peptides, peptide synthesis.
- Understand the protein structure, its purification and criteria of homogeneity.
- Explain mitochondrial and plastid genomes.

UNIT-III

Classification of lipids, physicochemical properties of fatty acids, fats and oils.Properties and biological roles of phospholipids and sphingolipids.Properties and Biological functions of prostaglandins.Chemistry and properties of cholesterol.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the classification and properties of fatty acids, fats and oils
- Describe the biological roles of phospholipids and sphingolipids.
- Understand the biological role of prostaglandins.
- Explain the structure and properties of cholesterol.

UNIT-IV

Nucleic acids – bases, nucleosides, nucleotides.Properties and functions of nucleic acids.Structure of DNA, Different forms of DNA.Circular DNA and DNA supercoiling.Chemical synthesis and sequencing of DNA.Types and structures of RNA. RNA double helices, triple helices, Watson Crick and Hoogsteen base pairing, mini double helices formed by ApU, GpU, turns bands in UpAH. Nucleotides as regulatory molecules and mediators of chemical energy in cells.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the structure of bases, nucleosides, nucleotides.
- Describe the properties of nucleic acids.
- Understand the structure of DNA, RNA and its forms.
- Explain base pairing, forming helices between A, U, G.
- Learn the importance of nucleotides as regulatory molecules and mediators.

UNIT-V

Enzyme nomenclature and classification; Enzyme kinetics: Introduction to catalysis and kinetics, Kinetics of single-substrate and multi-substrate enzyme-catalyzed reactions, Significance of kinetic constants; Enzyme inhibition, Enzyme specificity, Active site, Coenzymes, Metals and cofactors.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the nomenclature and classification of enzymes.
- Describe kinetics of single substrate and multi-substrate enzyme catalyzed reactions.
- Understand the specificity and inhibition.

Recommended books:

1. Principles of Biochemistry by Nelson and Cox 4th ed. Pearson
2. Biochemistry by Voet&voet 3rd ed. John Wiley and sons
3. Biochemistry by Matthews 3rd ed. PSN
4. Biochemistry by Lehninger 2nd ed. Kalyani Publishers
5. Biochemistry by Stryer 4th ed. WH Freeman and CO.

(MBI102): CELL BIOLOGY AND GENETICS

Course Objectives:

- To study the structure of bacteria, plant and animal cells, plasma membrane and membrane transport mechanisms.
- To understand the mechanism of cell cycle and its regulation.
- To understand and figure out signal transduction mechanisms in health and diseases.

UNIT-I

Outline of cell architecture. Ultrastructure of plasma membrane. Structure and functions of mitochondria, chloroplast, nucleus, endoplasmic reticulum, golgi, lysosomes, ribosomes, cytoskeletal elements. Membrane transport - Membrane channels and pumps, exocytosis and endocytosis.Intracellular trafficking.

Learning outcomes
By the end of this unit, the student will be able to

- Learn about structure of bacteria, plant and animal cells, plasma membrane and membrane transport mechanisms
- Gain knowledge of structure and functions of mitochondria, chloroplast, nucleus, endoplasmic reticulum, golgi, lysosomes, ribosomes, cytoskeletal elements, Intracellular trafficking.

UNIT-II

Microscopy – Phase contrast, fluorescent, confocal and electron microscopy. Cell cycle and its regulation.Extracellular matrix, cell-cell interactions. Cell - matrix interactions. Cellular communication – exosomes, bacterial chemotaxis and quorum sensing.

Learning outcomes
By the end of this unit, the student will be able to

- Understand the mechanism of cell cycle and its regulation, cell-cell and cell - matrix interactions.
- Able to understand the mechanisms of cellular communications in prokaryotic and eukaryotic cells.

UNIT-III

Signal transduction – General features, types of signal transducers. G - proteins, secondary messengers - cAMP, cGMP, calcium, DAG, IP3, nitric oxide. Receptor tyrosine kinases, Growth factor signaling cascade. Regulation of signaling pathways.

Learning outcomes
By the end of this unit, the student will be able to

- Understand the signal transduction mechanisms and their significance
- Able to explain RTK and Growth factor signaling cascade and their regulatory mechanisms.

UNIT-IV

Mendel's laws and their limitations. Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting,multiple alleles, linkage and crossing over.Linkage maps, mapping with molecular markers, tetradanalysis. Sex-linkage-sex limited and sex influenced characters. Mutations – types, molecular mechanisms and significance.

Learning Outcomes:
By the end of this unit, the student will be able to

- Describe the basic laws of inheritance
- Explain deviations from basic laws of inheritance
- Lay down the genetic mechanisms of inheritance and variations
- Interpret and find out the various genetic crosses observed in different experiments

UNIT-V

Homologous and non-homologous recombination.Extra chromosomal inheritance - episomes, mitochondria and chloroplast.Transposons.Genetic equilibrium and Hardy-Weinberg law. Fine structure of rII locus- Benzers experiments, Complementation testing.

Learning Outcomes:
By the end of this unit, the student will be able to

- Explain the mechanism of genetic recombination
- Differentiate extra-chromosomal inheritance from chromosomal
- Illuminate, how genetic equilibrium is maintained in the population
- Lay down the experimental strategies to find out gene structure

Recommended Books:

1. Molecular Biology of the Cell by B. Alberts *et al*. Garland publications incorporation, 4th Ed.
2. Molecular Cell Biology by Harvey Lodish*et. al*. W. H. Freeman, 4th Ed.
3. Cell and Molecular Biology by E. D. P. De Roberties, International edition.
4. The Cell: A molecular approach by Geoffery M Cooper, 2nd Ed.
5. Principles of Genetics by Sinnet, McGraw Hill, 5th Ed.
6. Harper's Biochemistry by Robert K. Murray, Langeman.
7. Principles of Heredity by Robert Tymarin.A, Tata McGraw Hill, 7th Ed.
8. Genetics by M. W. Strickberger, Mac Millan, 3rd Ed.

(MBI103): BIOLOGICAL DATABASES

Course Objectives

- To make students understand and differentiate between the wet-lab experimentation and data generation followed by computational applications of biological data.
- To provide the student with a strong emphasis in exploration and navigation of various biological databases to perform further research analysis in bioinformatics.
- To create opportunity to interact with algorithms, tools and data in current scenario.
- To find out the methods for analyzing the expression, structure and function of DNA, RNA and proteins, and an understanding of the relationships between species.

UNIT - I

Introduction to Bioinformatics; Types of Biological data and its applications using computational tools; Omics studies; Major resources of Bioinformatics – NAR databases, NCBI, EMBL-EBI and Expasy; Literature databases: PubMed, PubMed Central and Public Library of Sciences.

Learning Outcomes:
By the end of this unit, the student will be able to

- Choose biological data, submission and retrieval it from databases and understand the storage formats of information
- Explain about omics studies and their applications in bioinformatics analysis.
- Describe about major resources available for bioinformatics studies.

UNIT – II

Nucleic acid sequence databases - NCBI, EMBL and DDBJ; Protein sequence databases – NCBI Protein, TrEMBL and Uniprot; Similarity based search engines – BLAST and FASTA; Protein Domain & Motifs Databases – Prosite, ProDom, Pfam and InterPro.

Learning Outcomes:
By the end of this unit, the student will be able to

- Demonstrate the most important bioinformatics databases, perform text- and sequence-based searches, and analyze the results in light of molecular biological knowledge.

UNIT – III

Protein structure databases – RCSB PDB, SCOP and CATH; Metabolic pathway databases – KEGG, BioCyc and Reactome; Protein-Protein interaction databases – STRING, Consensus PathDB and BioGRID.

Learning Outcomes:
By the end of this unit, the student will be able to

- Demonstrate the most important protein bioinformatics databases, perform text- and structure-based searches, and analyze the results in light of three-dimensional molecular biological knowledge.
- Explain metabolic and protein-protein interaction networks and their importance in understanding biological networks.

UNIT – IV

Genome databases, Gene expression databases – 4DXpress, ArrayExpress and GEO (Gene Expression Omnibus); Human genetics databases – GeneCards and OMIM (Online Mendelian Inheritance in Man).

Learning Outcomes:
By the end of this unit, the student will be able to

- Demonstrate the most important gene expression databases, perform text searches, and analyze the results of microarray and other gene expression data.
- Carry out gene and protein expression patterns analysis and modeling cellular interactions and processes.

UNIT – V

Immunological databases – IMGT (international ImMunoGeneTics information system), IEDB (Immune Epitope Database) and AntigenDB; Cancer gene databases–canSAR, and CellLineNavigator.

Lerning Outcomes:
By the end of this unit, the student will be able to

- Demonstrate the most important immunoinformatics and cancer related databases.
- Carry out epitope prediction studies and various kinds of analysis using cancer gene datasets.

Reference Books:

1. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999
2. Lesk, A.M. (2014) "Introduction to Bioinformatics"; Oxford University Press, UK, Fourth edition.
3. JinXiong. Essential Bioinformatics, 01 Edition, 2009, Cambridge University Press.
4. Jonathan Pevsner. Bioinformatics and Functional Genomics, 3rd edition, Wiley.
5. David Mount, (2004), "Bioinformatics: Sequence and Genome Analysis"; Cold Spring harbour laboratory Press, US Revised Edition.

(MBI104): BASIC MATHEMATICS AND BIOSTATISTICS

Course Objectives:

- To understand the basics of mathematics for solving biological problems.
- To learn the basic concept, applications of limits and integrals which are required to solve real world problems.
- To identify and practice biostatistics concepts and techniques, for simple applications.
- To understand the concept of probability and sampling to solve real world problems using Binomial, Poisson and normal distributions.
- To understand the concept of testing of hypothesis, types of errors and level of significance.

UNIT-I

Basics of Mathematics: Linear algebra, Matrices, Solution of simultaneous and quadratic equations, Cubic equations – Solving system of equations by cramer's rule; 2D coordinate geometry – Straight line, slope, intersection, equation of a line, Point of intersection of a line, Parallel and perpendicular lines, Angle between lines.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Describe the basic concepts of mathematics.
- Choose appropriate method for solving equations.
- List the difference between methods used to solve equations.
- Describe the basic concepts of matrices.
- Understands the concepts of 2D coordinate geometry.

UNIT-II

Limits: Differentiation of elementary functions, sum and product of functions. Integration of simple functions, definite integrals.

Learning Outcomes
By the end of this Unit, the student will be able to

- Describe the basic concepts of limits and integrals.
- Compare and contrast different elementary functions.
- Use sum and product of functions.
- Illustrate the concept of integration of simple functions.
- Understands definite integrals.

UNIT-III

Basics of Statistics: Biostatistics – Introduction and applications, scientific data description, tabulation and graphical representation. Measures of central tendency – Mean, Median and Mode, Measures of dispersion – Range, Standard deviation, Standard error and Variance.

Learning Outcomes
By the end of this Unit, the student will be able to

- Outline the different applications of biostatistics.
- Apply biostatistics concept whenever required to real world datasets.
- Understands the importance of data description, tabulation and representation.
- Use measures of dispersion to understand data.
- Use measures of central tendency to understand data.

UNIT-IV

Probability and Sampling: Probability – Definition, Addition and Multiplication theorems, Conditional probability, Baye's theorem, Random variables, Discrete and Continuous probability distribution. Binomial, Poisson and normal distributions and their properties.

Learning Outcomes
By the end of this Unit, the student will be able to

- Identify the need of probability.
- Recall the basics of probability.
- Summarize different types of probability.
- Extend the probability concept on distribution.
- Recall the basics of distributions and extend to their properties.

UNIT-V

Types of errors -Type I and Type II errors. Level of significance, Testing of Hypothesis: F-test and Students't' test, Chi-square test, Correlation co-efficient, Regression analysis, ANOVA.

Learning Outcomes
By the end of this Unit, the student will be able to

- Compare and contrast type I and type II errors.
- Understand the level of significance.
- Choose appropriate methods like F-test, Students't' test, Chi-square test, and ANOVA to test the hypothesis.
- Demonstrate the correlation between two datasets.
- Apply the regression analysis concept on datasets whenever required for prediction.

Recommended Books:

1. Introduction to Mathematical methods in Bioinformatics by A. Isaev.
2. Discrete Mathematics by Malik.
3. Mathematics for Biological Sciences by Aitken
4. A text book of remedial Mathematics by G.K.Ranganath, Himalaya Publishing House.
5. Trignometry, Algebra and Calculus by Veerarajan, T., 3rd Ed, Tata McGraw Hill Publishing Co. Ltd.
6. Biostatistics by Arora, P.N. and Malhan, P.K by 1st Ed, Himalaya Publishing House.

(MBI105A): Research Methodology

Objectives:

1. Understand some basic concepts of research and its methodologies
2. Identify appropriate research topics
3. Select and define appropriate research problem and parameters
4. Prepare a project proposal (to undertake a project)
5. Organize and conduct research (advanced project) in a more appropriate manner

Unit I

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

Unit II

Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance , Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Unit III

Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

Unit IV

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Unit V

Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

Learning Outcomes:

1. Students will understand a general definition of research design.
2. Students will know why educational research is undertaken, and the audiences that profit from research studies.
3. Students will be able to identify the overall process of designing a research study from its inception to its report.
4. Students will be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research

Assessment Tools:

Written examinations, Case study discussions, Viva examinations.

Books Recommended:-

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari

(MBI105B): Science Journalism

Objectives

- Students will learn the mechanics of science writing, including research, sourcing, and generating story ideas; interviewing, note-taking, and organization; fact-checking, editing, writing for story, structure, and formatting.

- Students will practice writing for multiple public, academic, and professional audiences and contexts using writing strategies, conventions, genres, technologies, and formats to communicate effectively.

UNIT 1 Science communication at the end of the Enlightenment and the importance of notions of the public in the origin of modern science - development of new audiences for science in the Nineteenth century and the emergence of new science communication media (e.g. mechanics' institutes, science journalism, public museums and zoos) - advent of the figure of the scientist as public expert and the debate about 'Two Cultures' – difference between science journalism and science communication

UNIT 2 Introduction of Western science in India through missionaries, travelers, army and civilian army of the East India Company– science in the 18th and 19th century –emergence of Indian pioneer scientists – science teaching-– developments during post-Independence period – emerging areas of science and technology – convergence in study of science

UNIT 3 Institutions of science in India - the role of the Asiatic Society – Bose Institute – Indian Institute of Science - Council of Scientific and Industrial Research (CSIR) – Indian Space Research Organization (ISRO) – Indian Science Congress organizations for popularization of science – NCSTC and Vigyan Prasar – noted science societies at state level – Science and Technology Academies – awards for science communication and popularization.

UNIT 4 The boom in new media during the twentieth century and their impact on science journalism - role of a science page editor – popular science magazines in the west – science magazines in India – the ideal science reporter - scope of science journalism on radio & television in developing countries – science serials on radio and television – Bharat ki Chaap on Doordarshan – Science serials on All India Radio - tech news - understanding present market trends.

UNIT 5 Science as an essential element in political, corporate and community news – major issues in science journalism – environmental pollution – genetically modified crops – research for disease prevention and eradication – nuclear power – disaster mitigation – scientific knowledge for effective governance – the North-South divide in science research and scientific development.

Learning Outcomes

- They will appreciate the digital landscape within which science journalism exists today by learning: blogging in science journalism (honing your craft, developing a voice); how to get work (pitching and staying relevant); the value of social networks for science journalism (sharing stories, finding stories, joining discussions and finding sources); digital strategies employed by major news organizations (data visualization, multimedia, community building).
- Students will analyze and learn about the structure of several types of data including numbers, texts and documents. Students will learn the skills to examine, evaluate, and critique those data, extract patterns, summarize features, create visualizations, and provide insights, while learning to be sensitive to ethical concerns associated

Assessment Tools: Written examinations, Case study discussions, Viva examinations.

Reference Book:

1. Mass Communication: A Critical analysis, Keval J Kumar
2. Professional Journalism, M V Kamat
3. Theory and Practice of Journalism, B N Ahuja
4. Professional Journalist, John Hohenberg

5. Understanding Media, Marshall McLuhan 6. Journalism in India,Nadig Krishnamurthy, Mysore University Press
6. Barbara Gastel, Presenting Science to the Public.
7. Blum, Deborah, Knudson, Mary & Marantz Henig, Robin. A Field Guide for Science Writers: The Official Guide of the National Association of Science Writers. (2005)
8. D. Perlman, Science and the Mass Media.
9. Elise Hancock, Ideas into Words: Mastering the Craft of Science Writing. Baltimore and London: Johns Hopkins, 2003.
10. N Corcoran (Ed.). Communicating health: strategies for health promotion. Sage. (2013).
11. O.P. Jaggi, A Concise History of Science including Science in India.
12. R. Sundara, Popular Science in Mass Media.
13. Renata Schiavo, Health Communication: From Theory to Practice. John Wiley & Sons. 2013
14. Sharon, M. Friedman, Sharon, Woody, Carlol, L. Rogers (Ed) : Scientists and Journalists, Reporting Science as News.
15. Warren Burkett, News Reporting : Science Medicine and High Technology

(MBI106P): BIOCHEMISTRY AND CELL BIOLOGY LABORATORY

Quantitative analysis

1. Estimation of protein by Spectrophotometric method.
2. Estimation of protein by Lowry method.
3. Estimation of protein by Bradford method.
4. Determination of pK and pI value of an amino acid.
5. Estimation of total lipids.
6. Fractionation of egg proteins and its quantification.
7. Isolation of casein from milk and its quantification.

Cell Biology

1. Identification of different stages of mitosis in onion root tip
2. Identification of different stages of meiosis in onion flower bud
3. Isolation of mitochondria by ultracentrifuge

Recommended Books:

1. Biochemical methods by Sadasivam and Manikam, Wiley Eastern Limited.
2. An introduction to practical Biochemistry by D. T. Plummer, McGraw Hill.
3. Laboratory manual in Biochemistry by J. Jayaraman, Wiley Eastern Limited.
4. Introductory Practical Biochemistry by S. K. Sawhney and Randhir Singh, Narosa
5. Cell Biology : Practical Manual by Renu Gupta , SeemaMakhija and Ravi Toteja

(MBI107P): BIOLOGICAL DATABASES LABORATORY

1. Major bioinformatics resources: NCBI, EMBL-EBI, EXPASY.
2. Literature databases: PubMed, PMC and PLOS.
3. Nucleic acid sequence databases: NCBI, EMBL and DDBJ.
4. Protein sequence databases: Uniprot and TrEMBL.
5. Protein structure databases: PDB and SCOP.
6. Metabolic pathway databases: KEGG and Reactome.
7. Protein interaction databases: STRING and BioGRID.
8. Gene expression databases: 4DXpress, ArrayExpress and GEO.
9. Immunological databases – IMGT, IEDB and AntigenDB.
10. Signal pathway databases.
11. RNA databases.
12. Human specialized databases.
13. Cell organelle databases.
14. Genome and Proteome databases.
15. Plant databases.
16. Viral bioinformatic's resources.

(MBI201): BIOLOGICAL SEQUENCE ANALYSIS

Course Objectives:

- To understand the basics of biological sequence analysis; and handle and retrieve biological data for solving biological problems.
- To learn the concept, applications and methods of pairwise sequence alignment, which are required to solve real world problems.
- To learn and practice concept of multiple sequence alignment, for simple applications.
- To learn and practice concept of construction and evaluation of phylogenetic trees which are required to solve real world problems.
- To understand the concept of sequence patterns, profiles and their representations.
- To understand the concept of RNA secondary structure and their methods to predict the secondary structure of RNA.

UNIT-I

Introduction: Concepts in sequence analysis, File formats, Concepts of Sequence similarity, Scoring matrices-PAM and BLOSUM series, Keyword-based searches using ENTREZ, SRS and ARSA.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Describe the basic concepts of sequence analysis.
- List the difference between file formats used to handle biological data.
- Describe the basic concepts of sequence similarity.
- Compare and contrast scoring matrices; and apply them appropriately.
- Compare and contrast keyword based searches; and use keyword based searches to retrieve biological data from biological databases.

UNIT-II

Pairwise sequence alignments: Concepts of sequence alignment, Dot plot, Dynamic programming for local and global alignments, Linear space algorithm, Gap penalties function. Sequence-based searches: BLAST and FASTA. Hidden Markov Models for pairwise sequence alignment.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Describe the basic concepts of pairwise sequence alignment.
- Choose appropriate methods for aligning two DNA or protein sequences.
- Compare and contrast dynamic programming for local and global alignments.
- Compare and contrast sequence based searches; and the use of sequence based searches to retrieve biological data from biological databases.
- Understand the concept of Hidden Markov Models for pairwise sequence alignment.

UNIT-III

Multiple sequence alignment (MSA): Concept, Scoring systems and methods - multidimensional dynamic programming, progressive, hierarchical, iterative and profile alignment. HMM for multiple sequence alignment. Molecular phylogenetics and applications, Phylogenetic trees and sequence graphs, Tree construction methods: Distance based and Character based methods. Tree evaluation methods, Usage of phylogenetic tools such as Phylip, MEGA, PAUP.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Describe the basic concepts of multiple sequence alignment.
- Choose appropriate methods for aligning multiple DNA or protein sequences.
- Understand the concept of Hidden Markov Models for multiple sequence alignment
- Describe the basics of molecular phylogenetics and its applications.
- Understand methods to construct and evaluate phylogenetic trees.

UNIT-IV

Sequence patterns and profiles: Sequence patterns - motifs, profiles, tandem and interspersed repeats. Pattern representations - consensus, regular expression, position weight matrices and sequence profiles.Tools for searching sequence patterns - MEME, PHI-BLAST, SCanProsite, PRATT, Gribskov profiling, HMMer and PSIBLAST.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Describe the basic concepts of sequence patterns and profiles.
- List different sequence patterns and sequence profiles
- List different methods to represent sequence patterns and profiles
- Understands different tools to search sequence patterns.

UNIT-V

RNA secondary structure prediction by Nussinov folding algorithm, Energy minimization and Covariance models.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Describe the basic concepts of RNA secondary structure.
- Choose appropriate methods for prediction of secondary structure of RNA.
- List the difference between methods used to predict RNA secondary structure.

Recommended Books:

1. Essential Bioinformatics, Jinxiong, Cambridge University Press.
2. Bioinformatics: Sequence and Genome Analysis, Mount, D., 1st Ed, Cold Spring Harbor Laboratory Press.
3. Introduction to Bioinformatics, Lesk, A.M., 1st Ed, Oxford University Press.

(MBI202): BASIC PROGRAMMING

Course Objectives

- The fundamental task of programming a computer is finding a solution to problems using control statements and loops.
- The objective to study user defined data types provides a flexibility for application development.
- The objective to study operators is used for calculations and data comparisons.
- The objective to study about pointers is a back bone of effective memory handling
- The ability of student is developed to solve world real problems using C language
- The complete knowledge of C language will helps the student to develop logics which will help them to create programs and applications in C using functions, pointers, file handling.
- Learning the basic programming students can easily switch over to any other languages in future.

UNIT-I

Definition of a Computer - Characteristics and Applications of Computers – Block Diagram of a Digital Computer – Classification of Computers based on size and working – Central Processing Unit – I/O Devices, Primary, Auxiliary and Cache Memory – Memory Devices. Software, Hardware, Firmware and People ware – Definition and Types of Operating System – Functions of an Operating System – MS-DOS –MS Windows, UNIX.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the classification and application of computers
- Explains about different operating system and its functions

UNIT-II

Introduction to C, Features of C, Character Set, Constants, Variables, Data types, Key words, Operators, Basic I/O functions. Control Structures: If statement, if-else statement, nested if-else, Switch Statement, Break statement, Continue statement, go to statement. Loops – For loop, while loop, do-while loop.

Learning Outcomes:
By the end of this unit, the student will be able to

- Know the features of C and its importance
- Explain about C and their applications in bioinformatics analysis.
- Describe the concepts of structure oriented language.

UNIT-III

Functions – Need of functions, function parameters, passing values between functions, Calling Convention, function declaration and prototypes, Recursion. Arrays – Introduction, Initialization, Passing array elements to a function, Pointers and arrays, Concept of Strings and Structure: Array of string and standard library string functions. Structure declaration, members and variables, Initialization of structure, Nested structure.

Learning Outcomes:
By the end of this unit, the student will be able to

- Describe the user defined functions to solve the real time problems
- Explains about the concepts of Arrays, Strings and Structures.
- Exercise the concepts of Arrays, Strings and Structures to solve the real time problems

UNIT-IV

Concept of Unions – Declaration and initialization, File handling: File handling: File operations, File Opening Modes, Record I/O in Files, Text Files and Binary Files, Record I/O Revisited, Low level Disk I/O.

Learning Outcomes:
By the end of this unit, the student will be able to

- Describe the concepts of Unions
- Explains about the concepts of File handling and its operations.

UNIT-V

Introduction to Data structures, String Processing, Linked lists and Two-way lists, Linked representation of stacks, Linked representation of queues, Trees: Binary trees, AVL trees and B trees, Sorting: Bubble sort, Insertion sort, Selection sort, Merge and Radix sort.

Learning Outcomes:
By the end of this unit, the student will be able to

- Describe the concepts of Data structures and its representations
- Explains the use of linear and non-linear data structures like stacks, queues, linked list etc.

Recommended Books:

1. Let us C by Yashwant K., 4th Ed.
2. The C programming language by Ritchie, D.M., 2nd Ed.
3. Computer Fundamentals and Applications by Balaguruswamy E., 2nd Ed.
4. Data Structures with C (Schaum's Outline Series), Lipschutz Seymour, Mcgraw Hill
5. Introduction to Computers by Norton, P., 6th Ed.

(MBI203): MOLECULAR MODELING

Course Objectives

- To let students understand various methods of molecular modeling and their advantages, disadvantages and applications in biology.
- To provide brief idea of molecular and quantum mechanics and their role in generating computational models
- To understand the concept of energy minimization and molecular dynamics simulations of macromolecules
- To understand the steps of protein modeling, structure validation and alignment studies.

UNIT-I

Introduction to Molecular Modeling: Representation of chemical compounds and codes, Molecular surfaces, Molecular graphics, Molecular Modeling Methods - Outline, Advantages and Disadvantages of Molecular Mechanics, SemiEmpirical, Ab-Initio and Density Functional Theory.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the methods to model the molecules..
- Explain about various computer representations of molecules.
- Describe the formats of macromolecular structures.

UNIT-II

Molecular Mechanics: Force Fields – Definition and Features, Functional Forms – Bond stretching, Angle bending, Torsional terms, Out-of-plane bending, Crossterms, Electrostatic, Vander Waals and Hydrogen Bonding interactions, Force fields for biomolecules.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of force field and its features.
- Explain about various interactions involving in computation of molecular energy.
- Describe the variety of force fields available for biomolecules.

UNIT-III

Quantum Mechanics based Chemical Models: Semi empirical based Models, Schrodinger equation, Born-Oppenheimer approximation, Hartree-Fock approximation, LCAO approximation, Roothaan-Hall equations, Gaussian Basis Sets.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the implementation of quantum based chemical models.
- Describe the various approximation methods in computations of energy.

UNIT-IV

Energy Minimization and Simulations: Energy Minimization – Statement of Problem, Derivative and Non-Derivative Methods; Simulation Methods – Time Averages, Ensemble averages, Molecular Dynamics Methods, Monte Carlo Methods, Differences between MD and MC, Conformational Analysis.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the principle of energy minimization and MD simulations.
- Explain the steps involved in simulations of both MD and MC.
- Describe the concept of conformational analysis.

UNIT-V

Structural Bioinformatics: Methods to model protein structure - primary, secondary, tertiary. Structural quality assurance – Structure as models, Error estimation and precision, stereo chemical parameters, Ramachandran plot, CASP, Protein structure comparison and alignment methods- FSSP, CE, VAST and DALI.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the different approaches to model a protein molecule.
- Explain the steps involved in modeling of proteins and its validation.
- Describe the various protein comparison and structure alignment methods

Recommended Books:

1. Molecular Modeling: Principles and Applications by A.R. Leach 2nd Ed
2. Chemoinformatics by Johann Gasteiger, Thomas Engel, Wiley.
3. Computational Biochemistry and Biophysics by O M. Becker.
4. Structural Bioinformatics by Jenny and Philip, 2nd Ed.

(MBI204): MOLECULAR BIOLOGY

Course Objectives

- To understand the difference between prokaryotic and eukaryotic genetic material, types of genes and other organelle genomes (mitochondrial & plastid).
- To explain the concept of DNA replication and study the enzymes involved at both prokaryotic and eukaryotic levels.
- To learn about eukaryotic and prokaryotic promoters, RNA polymerase, mechanism and inhibition of transcription.
- To outline the concept of translation, genetic code, mechanism of protein synthesis, post translation modifications in eukaryotes, protein processing and targeting.
- To study prokaryotic and eukaryotic gene regulation, sporulation in *Bacillus subtilis*, DNA methylation and epigenetic gene regulation.

UNIT -I

Organization of genetic material in prokaryotes & Eukaryotes.Fine structure of gene.Types of genes.Gene amplification.Polytene chromosomes. C -value paradox. Mitochondrial and plastid genomes.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the organization of genetic material in prokaryotes and eukaryotes.
- Describe gene amplification, fine structure of gene and their types.
- Understand the concept of polytene chromosome and C- value paradox.
- Explain mitochondrial and plastid genomes.

UNIT-II

DNA Replication: DNA polymerases of Prokaryotes. Mechanism of replication in prokaryotes.Eukaryotic DNA polymerases.Mechanism of replication in eukaryotes. DNA damage and repair

Learning outcomes:
By the end of this Unit, the student will be able to

- List the differences between prokaryotic and eukaryotic DNA polymerases
- Outline the different enzymes involved in DNA replication.
- To understand the mechanism of DNA replication in prokaryotes and eukaryotes.
- Illustrate the basic concept of DNA damage and repair.

UNIT-III

Transcription: Prokaryotic RNA polymerase. Nature of prokaryotic promoters.Mechanism of prokaryotic transcription.Eukaryotic RNA polymerases.Nature of eukaryotic promoters, Mechanism of eukaryotic transcription.Inhibitors of transcription. Post transcriptional processing of rRNA, mRNA and tRNA. Processing of tRNA.RNA editing, transport.

Learning outcomes:
By the end of this Unit, the student will be able to

- Compare and contrast prokaryotic, eukaryotic RNA polymerases & promoters.
- To understand mechanism of prokaryotic and eukaryotic transcription.
- Study the inhibitors of transcription.
- To learn the concepts of post transcriptional modifications, RNA editing and RNA transport.

UNIT –IV

Translation: General features of genetic code. Structural components of prokaryotic and eukaryotic ribosomes.Mechanism of protein synthesis in prokaryotes and eukaryotes. Post translational modifications in eukaryotes. Protein synthesis inhibitors.Protein processing and targeting.

Learning outcomes:
By the end of this Unit, the student will be able to

- To learn the general features of genetic code
- Illustrate the structural components of prokaryotic and eukaryotic ribosomes.
- To highlight the mechanism of prokaryotic and eukaryotic protein synthesis.
- Details of eukaryotic post translational modifications.
- To study the inhibitors of protein synthesis.
- Explore the concepts of protein processing and targeting.

UNIT - V

Prokaryotic gene regulation: Lac and Trp operons. Lytic and lysogenic phases of Bacteriophage λ life cycle.Sporulation in Bacillus subtilis.
Eukaryotic gene regulation: Role of chromatin in eukaryotic gene regulation. Cis-trans elements, DNA methylation, chromatin remodelling. Environmental gene regulation.RNAi in gene regulation. Epigenetic gene regulation

Learning outcomes:
By the end of this Unit, the student will be able to

- Compare and contrast Lac and Trp operons.
- List the difference between lytic and lysogenic phases of bacteriophage λ life cycle.
- Highlight prokaryotic gene regulation through sporulation in *Bacillus subtilis*.
- Illustrate the role of chromatin and chromatin remodelling in eukaryotic gene regulation.
- Learn about DNA methylation and Cis-trans elements.
- Describe the concept of environmental gene regulation, epigenetic gene regulation and RNAi mediated gene regulation.

Recommended Books:

1. Molecular Biology of the gene by Watson, Pearson, 5th Ed.
2. Molecular Biology of the cell by Alberts, Garland science, 4th Ed.
3. Biochemistry by Voet and Voet, John Wiley and sons, 3rd Ed.
4. Molecular cell Biology by Lodish, Freeman, 6th Ed.
5. Principles of Biochemistry by Nelson cox. PALG, 4th Ed.
6. Molecular Biology by Robert F.Weaver, Mc Graw Hill

(MBI205A): Entrepreneurship

Course Objective

The goals of this programme are to inspire students and help them imbibe an entrepreneurial mind-set. The students will learn what entrepreneurship is and how it has impacted the world and their country. They will be introduced to key traits and the DNA of an entrepreneur, and be given an opportunity to assess their own strengths and identify gaps that need to be addressed to become a successful entrepreneur. The programme comprises several short courses, each focusing on a specific entrepreneurial knowledge or skill requirement such as creative thinking, communication, risk taking, and resilience and helping them become career ready, whether it is entrepreneurship or any other career.

Unit I **Contact Hours: 12**

Entrepreneurship: Concept of Entrepreneur, Entrepreneurship and Manager, Difference between Entrepreneur and Entrepreneur, Entrepreneurship, Attributes and Characteristics of successful entrepreneurs. Functions of an Entrepreneurs Function of an Entrepreneur, Classification of Entrepreneurs, Role of Entrepreneur in Indian Economy, Developing Entrepreneurial culture, Factors influencing Entrepreneurship Growth – Economic, Non-Economic Factors, For profit or Not for profit entrepreneurs, Constraints for the Growth of Entrepreneurial Culture, Entrepreneurship as a career, Entrepreneurship as a style of management, Emerging Models of Corporate Entrepreneurship, India's start up revolution-Trends, Imperatives, benefits: the players involved in the ecosystem, Business Incubators-Rural Entrepreneurship, social entrepreneurship, women entrepreneurs, Cases of Tata, Birlas, Kirloskar and new generation entrepreneurs in India.Case study on related topics.

Unit II **Contact Hours: 12**

Theories of entrepreneurship: Innovation Theory by Schumpeter & Imitating, Theory of High Achievement by McClelland, X-Efficiency Theory by Leibenstein, Theory of Profit by Knight, Theory of Social change by Everett Hagen.Case study on related topics.

Unit III **Contact Hours: 12**

Entrepreneurship development: Entrepreneurial Competencies, Developing competencies, concept of entrepreneurship development, Entrepreneur Training and developing, Role of Entrepreneur development Programs (EDP), Role of DIC, EDII, NIESBUD, NEDB, EDP – Objectives – contents – methods – execution, Mudra Yojna: Shishu, Kishore and Tarun Scheme. Role of Mentors. Innovation and Entrepreneurship, Design Thinking Process, Role of consultancy organizations in promoting Entrepreneurs, Problems and difficulties of Entrepreneurs – Marketing Finance, Human Resource, Production; Research – external problems, Mobility of Entrepreneurs,Entrepreneurial change, occupational mobility – factors in mobility.Case study on related topics.

Unit IV **Contact Hours: 12**

Role of Central government and State Government in promoting Entrepreneurship:Introduction to various incentives, subsidies and grants, Export Oriented Units, Fiscal and Tax concessions available, Women Entrepreneurs – Role, Problems and Prospects, Reasons for low women Entrepreneurs, Assistance Programme for Small Scale Units – Institutional Framework – Role of SSI Sector in the Economy – SSI Units – Failure, Causes and Preventive Measures – Turnaround

Strategies. Future of Entrepreneurship Development and Government, Start Up India, Make in India.Case study on related topics.

Unit V **Contact Hours: 12**

Enterprise Promotion: Creating Entrepreneurial Venture, Entrepreneurship Development Cycle, Business Planning Process The business plan as an entrepreneurial tool, Elements of Business Plan, Objectives, Market Analysis, Development of product/ idea –Resources, Capabilities, and strategies, identifying attributes of strategic resources, Opportunity Analysis, innovator or imitator, SWOT analysis, Internal and External Environment Analysis, Industry Analysis, Embryonic Companies and Spin off's, Porter's five forces model, Identifying the right Business Model Canvas, Seven Domains of John Mullins, Opportunities in Emerging/Transition/Decline industries, Opportunities at the bottom of the pyramid, Opportunities in social sector, Opportunities arising out of digitization, Marketing, Finance, Organization & Management, Ownership – Franchising, networking and alliances, Buying an existing business, Critical risk contingencies of the proposal, Scheduling and milestones.Case study on related topics.

Text Books:

1. Vasant Desai (2011), Dynamics of Entrepreneurship Development, Himalaya Publishing House.
2. David H. Holt, (1991) Entrepreneurship: New Venture Creation, Prentice Hall.
3. K. Nagarajan, (2017) Project Management, New Age International Pvt Ltd.

Reference book:

1. The Culture of Entrepreneurship, Brigitte Berger.
2. Entrepreneurship: Strategies and Resources, Marc J, Dollinger.

(MBI205A): Intellectual Property Right

Objectives

1. To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries and Research.
2. To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
3. To disseminate knowledge on copyrights and its related rights and registration aspects
4. To disseminate knowledge on trademarks and registration aspects
5. To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects
6. Too aware about current trends in IPR and Govt. steps in fostering IPR and case studies.

Unit-I Overview and Introduction of Intellectual Property **12 Hrs**

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967,the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994, Phonograms or Geneva Convention, History of IPR.

Unit-II Patents and Drafting **12 Hrs**

Patents - Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board, Patent Filing and Drafting Case studies, Patent Agents role in India.

Unit-IIICopyrights in IPR **12 Hrs**

Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright - Infringement, Remedies &Penalties – Related Rights - Distinction between related rights and copyrights, Filing and Drafting the Copyrights.

Unit-IV Trademarks and Trading licenses **12 Hrs**

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non-Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademark's registry and appellate board, Trading license importance of exports and imports in trading.

Unit-V IP transactions; Enforcement of IP, Commercialization **12 Hrs**

Implications of Intellectual Property Rights in promoting innovations and their commercialization; technology transfer, Due diligence in patent transactions. Working of patents in India Compulsory license and its implications; Enforcement of Patents against infringer.

Industrial Designs Registrations: Classification, Protection and Enforcement of Industrial Designs in Indian. Registration and protection of design in India and abroad.

Geographical Indications: Concept of Geographical Indications and GI registration in India; Global scenario of GI. Protection of Traditional Knowledge and development of balanced benefit sharing models; management of GI to enhance the economic returns from GIs. Enforcement of GI. GI registrations process in India Case studies. Case Studies and Discussions related to IPR

TEXT AND REFERENCE BOOKS:

1. Rimmer, M. (2008). Intellectual property and biotechnology: biological inventions. Edward Elgar Publishing.
2. Singh, H. B., Jha, A., &Keswani, C. (Eds.). (2016). Intellectual property issues in biotechnology. CABI.
3. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
4. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

Learning Outcomes

1. The students once they complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works during their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search.
2. This course provides further way for developing their idea or innovations.
3. To Pave the way for the students to catch up Intellectual Property (IP) as a career option a. R&D IP Counsel b. Government Jobs – Patent Examiner c. Private Jobs d. Patent agent and Trademark agent e. Entrepreneur

E-resources:

1. Subramanian, N., &Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf

2. 2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf

Reference Journal: 1. Journal of Intellectual Property Rights (JIPR): NISCAIR http://nopr.niscair.res.in/handle/123456789/45 (Case Studies)

Useful Websites:

1. Cell for IPR Promotion and Management (http://cipam.gov.in/)
2. World Intellectual Property Organisation (https://www.wipo.int/about-ip/en/)
3. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

(MBI206P): BIOLOGICAL SEQUENCE ANALYSIS AND PROGRAMMING
LABORATORY

Biological Sequence Analysis Laboratory

1. Sequence alignment
    a. Needleman-Wunsch method.
    b. Smith Waterman method (FASTA).
2. Searching Homologs using various BLAST Variants.
3. Multiple sequence alignment
    a. Multiple sequence alignmentfor nucleotide and protein data
    b. Understanding effect of scoring matrices and gap penalties on multiple sequence alignment.
4. Construction and assessing the phylogenetic tree
    a. Construction of phylogenetic tree using UPGMA, neighbor joining, maximum parsimony, and maximum likelihood methods for nucleotide and protein data.
    b. Assessing the confidence of phylogenetic tree by bootstrap or interior branch test.
5. RNA secondary structure prediction.
6. HMM profiles.

Basic Programming in C Laboratory

1. Program for transcription and translation.
2. Program for concatenation of two strings and reverse complement.
3. Program for sequence base count of DNA and amino acids count in protein.
4. Program for finding stop codon position and given patterns in a sequence.
5. Program for calculating GC% in a sequence.
6. Program for sequence alignment and motif search.

(MBI207P): MOLECULAR BIOLOGY AND MOLECULAR MODELING LABORATORY

Molecular Biology Laboratory

1. Isolation of DNA from plant tissue/animal cells and determination of its concentration and purity by spectrophotometeric method.
2. Isolation of plasmid DNA from bacteria and determination of its concentration and purity by spectrophotometeric method.
3. Estimation of DNA using Diphenylamine reagent.
4. Determination of Tm of DNA & estimation of G+C content.
5. DNA electrophoresis in agarose gel.
6. Isolation of RNA from Yeast and determination of its concentration and purity by spectrophotometeric method.
7. Estimation of RNA using Orcinol reagent.
8. RNA electrophoresis in formaldehyde-agarose gel.

Molecular Modeling Laboratory

1. Chemical Databases.
2. Generating 3D Representation from 2D Description of Small Molecules.
3. Computing Structural Properties of Small Molecules.
4. Molecular Graphics – Visualization of Macromolecules.
5. Protein Primary and Secondary Structure Analysis.
6. Protein Tertiary Structure Prediction by
   a) Homology Modeling, b) Fold Recognition, c) Ab-Initio.
7. Protein Steroechemical property analysis.
8. Expasy proteomics resources: Sequence sites, features and modifications.
9. Structure Alignment and Comparison.
10. Energy Evaluation and Geometry Optimization.
11. Polypeptide Conformation Analysis by
    a) Molecular Dynamics Simulation, b) Monte Carlo Simulation.

(MBI301): GENOMICS & PROTEOMICS

Course Objectives

- To acquire knowledge on genome sequencing strategies, methods of assembly and comparative genomics.
- To identify different regions of genome sequence with predicting their functions using different methods.
- To understand different strategies and methods employed in protein separation and quantification for whole samples of proteins at a time.
- To attain basic principles involved in protein structure determination and correlating structure to function.
- To know the different application of genomics and proteomics in clinical, plant breading and genetically modified plants.

UNIT-I

Genome Sequencing and Assembly: Genome sequencing strategies - shot gun, hierarchal, Fragment and map assembly, Genome assembly and annotation, tools for genome assembly - Phred, Phrap, Consed. Metagenomics and their uses.Basic concepts and applications of comparative genomics, Tools for comparative genomics.

Learning Outcomes:
By the end of this unit, the student will be able to

- Explain the strategies employed in genomics with their advantages and disadvantages.
- Understands fragment and map assembly which is required for genome assembly.
- Describe about the tools employed in genome assembly and annotating the genome sequencing.
- Understand the importance of metagenomics and its application.
- Describe the basic concepts of comparative genomics, tools used and its applications.

UNIT-II

Structural and Functional Genomics: Identification and annotation of exons, introns, promoters, enhancers, DNA motifs, splice sites, repetitive elements, CpG islands. Assigning gene functions - sequence based, structure-based, derived databases, machine learning approaches. SNP arrays, cDNA, EST, SAGE, MPSS, RNA expression, DNA microarray and its applications.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understands the basic concepts of Structural and Functional Genomics.
- Describe the methods to employ to identify gene segments in prokaryotes and eukaryotes (like exons and introns) in genome sequence.
- Explain the process of identification regulatory parts in genome sequence like promoters, enhancers, DNA motifs, repetitive elements and CpG islands.
- Explain about the sequence based, structure based and machine learning approaches to assign gene functions.
- Understand the importance of different methods like SNP arrays, EST, SAGE, DNA microarray in genomics.

UNIT-III

Need, Scope, Challenges and Applications of Proteomics. Strategies for protein separation – Preparation of extract, Measurement of protein quantity.Protein purification by Precipitation, Adsorption – Gel permeation, HPLC, Ion-exchange, Affinity chromatography and Gel filtration. Novel approaches to protein expression analysis – 2D-gel electrophoresis, DIGE and protein chip technology.

Learning Outcomes:
By the end of this unit, the student will be able to

- Enumerate the need, challenges and application of proteoimcs.
- Describe methods employed in protein separation for basic small samples
- Explain principles behind different purification methods and their quantification
- Understand the complex analysis methods employed in proteomics like 2DGE, DIGE and protein chip technology.

UNIT-IV

Protein sequence-structure-function relationship, Techniques for solving protein structures - XRD, NMR, Mass spectroscopy – MALDI-TOF, ESI-MS, Tandem-MS, Protein-Protein Interaction, Library based methods - Phage interaction display and Yeast Two-Hybrid system, Protein-DNA interactions.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understands the relationship between protein sequence-structure-function.
- Explain about the different technologies engaged for protein structure determination like XRD, NMR and Mass Spectroscopy.
- Describe the principles behind the XRD, NMR and Mass Spectroscopy with their advantages and disadvantages.
- Enlighten the methods to find the protein function using protein structure and protein-protein interaction methods
- Understand the protein-DNA interactions to solve biological problems.

UNIT-V

Application of genomics and proteomics: Clinical proteomics - Discovery of Biomarker. Target identification and development of drugs.Plant proteomics - plant breeding and genetics, analysis of genetically modified plants, analysis of secondary metabolism.

Learning Outcomes:
By the end of this unit, the student will be able to

- Illustrate the different applications of genomics and proteomics.
- Explain the use of genomics and proteomics in biomarker discovery.
- Understand the importance of genomics and proteomics in drug targeting.
- Describe the application of genomics and proteomics in plant breeding and genetically modified plants.
- Describe the application of genomics and proteomics in analysis of secondary metabolites.

Recommended books:

1. Bioinformatics, Andrzej Polanski and Marek Kimmel, First Edition, Springer Publications.
2. Bioinformatics and Functional Genomics, Pevsner, J., John Wiley and Sons.
3. Principles of genome analysis and Genomics, Primrose, S.B. and Twyman, R.M., 3rd Ed, Blackwell PubComp
4. Essential Bioinformatics, Jinxiong, Cambridge University Press.
5. Bioinformatics: Sequence and Genome Analysis, Mount, D., 1st Ed, Cold Spring Harbor Laboratory Press.
6. Essentials of Genomics and Bioinformatics, Sensen, C.W., First Edition, Wiley-VCH Publishers.
7. Principles of Proteomics – RM. Twyman, Spl. Indian Ed.
8. Introduction to protein science – AM. Lesk, 2nd Ed.
9. Protein Purification: Principles and Practice – RK. Scopes, 3rd Ed.
10. Proteomics: From Protein sequence to Function – Pennington and Dunn.

(MBI302): OMICS AND SYSTEMS BIOLOGY

Course Objectives

- To understand concept and applications of Next Generation Sequencing (NGS) technologies along with their advantages and disadvantages to solve real world biological problems.
- To understand principles of structure, behavior, design, control and measurements of systems along with their applications.
- To attain basic principles and methodologies involved in modeling and simulation of systems along with their advantages and disadvantages.
- To describe the principles, paradigm, measurement, analysis, control of metabolic systems biology with their uses.
- To know the concept and types of biological networks in biology to solve real world biological problems.

UNIT-I

OMICS: Next Generation Sequencing technologies for generating NGS or omics data and their applications - Whole genome sequencing, RNA sequencing, epigenome sequencing, single cell sequencing. Epigenomics, Trancriptomics, Phosphoproteomics, Metabolomics, Interactomics, Glycomics, Lipidomics, Ubiquitonomics, Fluxomics, Phenomics.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understands the concept of generating data by Next Generation Sequencing (NGS) technologies.
- Compare and contrast five generations of NGS technologies; and describe the principles of NGS technologies with their advantages and disadvantages.
- Understands the applications of NGS technologies to solve real world biological problems.
- Understand the omics like Epigenomics, Trancriptomics, Metabolomics and Interactomics to understand
- Understand the special omics likePhosphoproteomics, Glycomics, Lipidomics, Ubiquitonomics, Fluxomics, Phenomics.

UNIT-II

Basics of Systems Biology: Introduction, basics and applications of systems biology. System Structure Identification, System Behaviour Analysis, System Control, System Design, Measurement for Systems Biology.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understands the basic concepts of systems biology and their applications.
- Describe different structures of system and identify system structure.
- Explain understand and analyze system behavior.
- Explain and understand system design and control.
- Describe the principles behind the measurement of systems.

UNIT-III

Modeling approaches in Systems Biology: Differential equation, Dynamic systems theory, Dealing with uncertainty.*Insilico* cell simulation: Whole cell simulation, Virtual erythrocytes, Minimal gene complement and Quorum sensing.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the modeling and simulation methodologies for systems biology.
- Explain about the differential equation for modeling systems.
- Describe the principles of dynamic systems theory with advantages and disadvantages.
- Explain about*insilico* cell simulation with special reference to whole cell simulation and virtual erythrocytes.
- Understand the role of minimal gene complement and quorum sensing in *insilico* cell simulation.

UNIT-IV

Metabolic systems biology: Basic principles and paradigm, Metabolome-Definition, measurement and uses, Analysis Methods: Bifurcation analysis, Metabolic control analysis, Flux balance analysis and Sensitivity analysis.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of metabolic systems biology.
- Describe the principles and paradigm of metabolic systems biology with their advantages and disadvantages.
- Explain about metablome measurement, analysis and their uses.
- Compare and contrast metablome analysis methods.
- Describe the principles behind the bifurcation analysis, metabolic control analysis, flux balance analysis and sensitivity analysis with their advantages and disadvantages.

UNIT-V

Network Biology: Introduction, Types of biological networks – Gene, protein networks and interaction maps. Topology and analysis, Databases, Visualization tools, Construction and Modelling of networks and Applications.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of network biology to solve real biological problems.
- Explain about the different types of biological networks and their role.
- Describe the principles behind the topology and analysis of biological networks with their advantages and disadvantages.
- Describe about the databases and visualization tools used to understand to biological networks.
- Understand about construction and modeling of biological networks along with their applications.

Recommended Books:

1. Foundations of Systems Biology by Hiroaki Kitano, 1st Ed, The MIT Press.
2. Molecular Cell Biology of the Cell by Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K and Walter, P, 4th Ed, Taylor and Francis Group.

(MBI303): ADVANCED PROGRAMMING

Course Objectives

- To introduce the features of database management systems and Relational database and concepts of SQL as a universal Database language
- Understand the fundamentals of object-oriented programming in Java, including defining classes, objects, etc for good programming skills and software development.
- The major objective of Perl and Bio-Perl and their application in bioinformatics makes an convenient way to handling and analysing the complex data.

UNIT -I

DBMS: Database systems - Organization, Functions and Components of DBMS, Data abstraction, Database languages, Data Models, Codd's Rules, Data Normalization and its forms. SQL-Introduction, Characteristics and Advantages, Basic structure of SQL queries.

Learning Outcomes:
By the end of this unit, the student will be able to

- To understand the basic concepts regarding database, know about database systems and techniques involved in query optimization and understand the concepts of database management system.
- To understand the difference between DBMS and advanced DBMS and use of advanced database concepts and become proficient in creating database queries

UNIT-II

JAVA: Introduction and Applications, Variables and Operators, Control Structures, OOPs concept, Arrays, Applet class. HTML - Basics, Applet HTML tag. Database connectivity - TCP/IP, UDP, servers, client setup.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand about basic Java language concepts such as variables, conditional and iterative execution methods etc.
- Understand the fundamentals of object-oriented programming in Java, including defining classes, objects, etc
- Understand the fundamental of basics HTML and database connectivity

UNIT-III

BIOJAVA: Alphabets and Symbols, Basic Sequence Manipulation, Translation, Proteomics, Sequence I/O, Annotations, Locations and Features, BLAST and FASTA, User Interfaces, Genetic Algorithms.

Learning Outcomes:
By the end of this unit, the student will be able to

- To know about bio java concepts for processing biological data
- To know about bio java concepts for processing bioinformatics analysis using sequence, BLAST and FASTA etc.

UNIT-IV

PERL: Introduction, Data Types – Lists, Arrays and Hash, Scalar functions, Quoting basics, Functions and Subroutines, Operators and Control Structures, Pattern Matching and Regular Expressions, File Handling and Manipulation, Error handling, Special variables.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the basic concepts of Perl to perform wide tasks
- Understand the basic concept of web development and network development
- Perl language helps students to develop algorithms

UNIT-V

BioPERL: BioPERL: BioPerl Modules - Sequences and Strings, Motifs and Loops, Debugging, Comprehensive PERL archive network, Restriction maps and Restriction enzyme data, Working and analyzing with GenBank and BLAST data, Text and String Processing.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concepts of Bio perl modules
- Gains a knowledge of analyzing biological data using Bio perl modules

Recommended Books:

1. Beginning Perl for Bioinformatics by Tisdall, J.D., 1st Ed O'Reilly Publishers.
2. Programming Perl by Wall, W., Christiansen, T. and Orwant, J., 3rd Ed, O'Reilly Publishers.
3. Java-2: The complete Reference by Naughton, P. and Schildt, H., 3rd Ed, McGraw Hill Publishers.
4. Computing Concepts with Java 2 Essentials by Horstmann, C.S., 2nd Ed, John Wiley Publishers.

(MBI304A): MICROBIOLOGY AND IMMUNOLOGY

Course Objectives:

1. To know the scope and development of microbiology and contributions of various scientists towards it.
2. To learn various cultural techniques and methods of microbial identification.
3. To learn the general characteristics, morphology and pathogenesis of various clinically important microorganisms.
4. To have an overview of immune system.
5. To learn about various classes of antibodies, cells of immune system and types of hypersensitivity.
6. To learn about various immunological techniques, transplantation immunology and immunomodulation.

UNIT - I

Development and Scope of Microbiology: Contributions of Antony Van Leeuwenhock, Joseph Lister, Pasteur, Koch, Jenner, AM Chakraborty. Microbial cultures- concept of pure culture and development.Identification methods – nutritional, cultural, biochemical, antigenic, ecological and ribotyping.Microbial interactions - mutualism, protocoperation, commensalism, predation, parasitism, competition and symbiosis.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Study the scope and development of microbiology and contributions of various scientists towards it.
- Learn various cultural techniques and methods of microbial identification.
- Learn various microbial interactions.

UNIT – II

Clinical Microbiology: general characteristics, morphology and pathogenesis of Bacteria - *Staphylococcus, Bacillus, Mycobacteria, Salmonella, Vibrio,* Fungi – *Candida. V*iruses - HIV, *Hepatitis, Influenza.*Life cycle of *Plasmodium* and *Entamoeba histolytica.*Immune response during bacterial (tuberculosis), parasitic (malarial) and viral (HIV) infections.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the general characteristics, morphology and pathogenesis of various clinically important microorganisms.
- Learn the Life cycle of *Plasmodium* and *Entamoeba histolytica*
- Learn the Immune response during bacterial, parasitic and viral infections.

UNIT-III

Overview of immune system.Organs of immune system –primary and secondary, Immune Cells - B and T cells. Humoral and Cell mediated immunity. Innate and Adaptive immunity.Immune responses.Immune regulation.Antigens, Superantigens, Haptens, Epitopes, Adjuvants.Processing and presentation of antigens, APC's, receptors - BCR, TCR.MHC and HLA - types, polymorphism and role.Clonal selection of lymphocytes.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the various Organs of immune system.
- Learn the types of Immune Cells and their role in immune responses.
- Learn the components of immune regulation.
- Know about clonal selection of lymphocytes

UNIT-IV

Cytokines, Interleukins Interferon's and their role. Immunoglobulin classes, structure and function. Isotypes, Allotypes and Idiotypes. Antibody diversity. Complement components and its role. Antigen-Antibody interactions and types. Types of hypersensitivity. Immunodeficiencies - SCID and AIDS. Autoimmunity and breakdown of self - tolerance.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn about Cytokines, Interleukins Interferons and their role
- Learn the classes of immunoglobulins, their structure and function..
- Learn about Antigen-Antibody interactions and types
- Learn about types of hypersensitivity
- Know about Autoimmunity and breakdown of self - tolerance

UNIT-V

Immunological tolerance and immunosuppression. Immune techniques- Rocket Immunoelectrophoresis, Immunoelectrophoresis, Immuno-flourescence, FACS, RIA, ELISA, FISH, GISH. Hybridoma technology - Monoclonal antibodies and their applications. Vaccines and their types, Transplantation immunology. Immunomodulation.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn about Immunological tolerance and immunosuppression.
- Learn about various Immune techniques.
- Learn about Monoclonal antibodies and their applications
- Learn about Vaccines and their types
- Know about Transplantation immunology. Immunomodulation.

Recommended Books:

1. Microbiology by Prescott, Tata McGraw –Hill, 7th Ed.
2. Textbook of Microbiology by Ananthnarayan, ORIE, 7th Ed.
3. Microbiology by Pelczar, Tata McGraw-Hill, 5th Ed.
4. Immunology Kuby.

(MBI304B): GENETIC ENGINEERING

Course Objectives

- To understand the concept of recombinant DNA technology, mapping of genes and chemical synthesis of genes.
- To compare different types of cloning and expression vectors. To learn about construction and screening of gene libraries.
- To learn about different types of gene transfer and blot analysis techniques.
- List several present day applications of genetic engineering and analyse the benefits and drawbacks of manipulating an organism's DNA
- Learn the concept of RNA silencing
- To study various methods of gene therapy, delivery systems for gene therapy and applications of genetic engineering.

UNIT – I

Outlines of recombinant DNA technology.Restriction endonucleases, RFLP, restriction maps.Mapping genes – chromosomal walking, chromosomal jumping. Isolation of gene fragments using restriction endonucleases, cDNA, PCR, RACE PCR. Chemical synthesis of genes.Ligation of fragments.

Learning outcomes:
By the end of this unit, the student will be able to

- Learn the outlines of recombinant DNA
- Concept of mapping genes- chromosomal walking and chromosomal jumping
- Understand the concept of chemical synthesis of genes and ligation of fragments.
- Explain isolation of gene fragments using restriction endonucleases, cDNA, PCR and RACE PCR.

UNIT – II

Cloning vectors – plasmids, bacteriophages, cosmids, Ti - plasmid. Expression vectors, CRISPR-Cas 9 technology. Construction of gene libraries – cDNA library, genomic library, YAC, BAC library. Cloning strategies – shot gun experiments, cDNA cloning in bacteria. Screening of libraries

Learning outcomes:
By the end of this unit, the student will be able to

- Compare and contrast cloning and expression vectors.
- To learn the concepts of construction of gene libraries and its types
- To highlight cloning strategies- short gun experiments and cDNA cloning in bacteria.
- Illustrate the concept of screening of libraries.

UNIT – III

Gene transfer techniques: Biological delivery systems - *Agrobacterium tumefaciens*, SV40, Retroviral systems, Artificial delivery systems - Gene gun, Microinjection, Lipofection, Electroporation, Ca - DNA coprecipitation. Identification of recombinants. Expression of cloned genes in bacteria, plant and animal cells. Blot analysis - Southern, Northern and Western blot, dot and slot blot.

Learning outcomes:
By the end of this unit, the student will be able to

- Learn about the different gene transfer techniques.
- Compare and contrast biological and artificial delivery systems.
- To understand the mechanism of expression of cloned genes in bacterial, plant and animal cells.
- To learn the concept of different types of blot analysis.

UNIT - IV

Transgenic plants - production of golden rice, transgenic animaIs – mouse and sheep.
RNA silencing – siRNAs, shRNA and anti- sense RNAs -mechanism and applications

Learning outcomes:
By the end of this unit, the student will be able to

- To highlight the importance of transgenic plants and animals.
- To learn the concept of RNA silencing and its mechanism
- Explore the applications of RNA silencing.

UNIT – V

Gene therapy: Methods of gene therapy- *Ex vivo, In situ, In vivo*, somatic and germline. Types and use of rDNA constructs for Gene therapy, Delivery systems for gene therapy. Biological, Medical and Industrial applications of genetic engineering.

Learning outcomes:
By the end of this unit, the student will be able to

- Illustrate the different methods of gene therapy.
- List the types and application of rDNA constructs for gene therapy.
- Describe the different delivery systems for gene therapy.
- Highlight the applications of genetic engineering in biological, medical and industrial fields.

Recommended Books:

1. Human Molecular Genetics by Tom Strachan and Andrew Read, Taylor & Francis Publisher, 3rd Ed.
2. Principles of gene manipulation & genomics by Primrose &Twyman, Oxford, 7th Ed.
3. Molecular cell biology by Lodish, Freeman, 6th Ed.
4. Molecular Biotechnology - Principles and applications of Recombinant DNA by Glick, 2nd Ed.

(MBIOE305A): CANCER – DIAGNOSIS, THERAPY AND PREVENTION

Course Objectives:

- To study the characteristics, sign and symptoms, types and risk factors of cancers and epidemiology of breast, cervical, oral and lung cancers.
- To identify different types of carcinogens and understand mechanism of carcinogenesis.
- To study the role of oxidative stress in cancer.
- To learn about mechanism of tumor formation, spread of cancer cells and biology of cell death.
- To list out common myths and misconceptions of cancer.
- To learn about clinical examination of cancer and applications of computational tools in cancer prediction.
- To understand the role of antioxidants and dietary fibre and yoga and meditation in cancer prevention.

UNIT I

Overview:
Normal vs Cancer cell. Characteristics of cancer and cancer cells. Sign and symptoms of cancers. Risk factors of cancer - Life style and dietary factors. Benign and malignant tumors. Types of cancers. Epidemiology of breast, cervical, oral and lung cancers.

Learning outcomes
By the end of this unit, the student will be able to

- Know about characteristics, sign and symptoms, types and risk factors of cancers
- Learn about epidemiology of breast, cervical, oral and lung cancers.

UNIT II

Carcinogenesis:
Carcinogens and carcinogenesis. Environmental carcinogens. Oxidative stress and Cancer. Concept of tumor suppressor and oncogenes.

Learning outcomes
By the end of this unit, the student will be able to

- Able to identify carcinogens and understand the mechanism of carcinogenesis
- Understand relation between oxidative stress and cancer.
- Understand the concept of tumor suppressor and oncogenes.

UNIT III

Pathology:
Tumor formation - Initiation, promotion and progression. Spread of cancer cells. Biology of cell death. Common myths and misconceptions of cancer.

Learning outcomes
By the end of this unit, the student will be able to

- Understand mechanism of tumor initiation, promotion and progression.
- To learn the mechanism of spread of cancer cells, biology of cell death.
- To learn about common myths and misconceptions of cancer.

UNIT IV

Prediction and Diagnosis:
Clinical examination - Blood Tests, Pap smear test and Biopsy. Radiological examination - X-rays, CT scan, MRI and Mammography. Applications of Computational tools in cancer prediction.

Learning outcomes
By the end of this unit, the student will be able to

- Learn about clinical examination of cancer by blood tests, pap smear test and biopsy. Learn about diagnosis of cancer by X-rays, CT scan, MRI and Mammography.
- Able to apply computational tools in cancer prediction

UNIT V

Prevention and therapy:
General principles of cancer therapy. Biomedical applications of nanotechnology in cancer prevention. Concept of cancer vaccine. Antioxidants and dietary fibre in cancer prevention. Complementary therapy – Yoga and meditation.

Learning outcomes
By the end of this unit, the student will be able to

- Understand general principles of cancer therapy
- Gain knowledge about biomedical applications of nanotechnology in cancer prevention.
- Understand the concept of cancer vaccine.
- Understand the role of antioxidants and dietary fibre and yoga and meditation in cancer prevention.

Recommended Books:

1. Molecular Pathology and Diagnostics of Cancer (Cancer Growth and Progression), Domenico Coppola, Springer.
2. An Introduction to Cellular and Molecular Biology of Cancer, Oxford Medical publications.
3. The Biology of Cancer, Janice Gabriel, John Wiley & Sons Ltd., 2nd Ed.
4. Cancer Biology, Raymond W. Ruddon, Oxford University Press, Inc., 4th Ed.
5. Introduction to Cancer Biology, MomnaHejmadi, Ventus Publishers. Molecular Biology of Human Cancers, Wolfgang Arthur Schulz, Springer Science, Business Media, Inc.

(MBIOE305B): FUNDAMENTALS OF BIOINFORMATICS

Course Objectives

- To understand explosion, nature and types of biological data and its role in biological research to solve real world biological problems.
- To understand the concept and applications of bioinformatics to solve real world biological problems.
- To understand the concept and types of literature databases, nucleic acid databases, gene expression databases, RNA databases, genome databases, and protein databases; and their uses to understand to biology.
- To understand the concept of specialized databases like metabolic pathway databases, signaling pathway databases, immunological databases, cell organelle databases, human genetics databases, polymorphism databases, cancer gene databases, gene-, and system- or disease-specific databases to solve real biological problems.
- To, understand the concept and principles of keyword and sequence based database searches to retrieve the biological data from biological databases.

UNIT-I

Introduction to bioinformatics: Scope of computers in Biological research, Biological Data, Retrieving and analyzing the data, Nature and Types of Biological Data, Explosion of biological data.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of bioinformatics to solve real biological problems.
- Explain about the scope of computers and their role in biological research.
- Describe the principles behind retrieving and analyzing biological data.
- Describe about the nature and types of biological data to understand to complex biological networks or systems.
- Illustrate the explosion of biological data and its role in biological research.

UNIT-II

Literature databases: Pub Med, Bio Med Central, Public Library of Sciences (PloS), CiteXplore.

Learning Outcome:
By the end of this unit, the student will be able to

- Understand the concept and types of literature databases and their role biological research.

UNIT-III

Nucleic acid databases - NCBI, EBI and DDBJ, EST, STS, GSS, Gene expression databases, RNA databases, Genome databases. Protein databases – Uniprot, PDB, SCOP, CATH.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept and types of nucleic acid databases.
- Understand the concept and types of gene expression databases.
- Describe about RNA and Genome databases their uses to understand to biology.
- Understand the concept and types of protein databases.

UNIT-IV

Specialized databases: Metabolic pathway databases, Signalling pathway databases, Immunological databases, Cell organelle databases, Human genetics databases, Polymorphism databases, Cancer gene databases, Gene-, system- or disease-specific databases.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of specialized databases to solve real biological problems.
- Explain about specialized databases – metabolic and signaling pathway databases.
- Describe about specialized databases - immunological databases, cell organelle databases with their advantages and disadvantages.
- Understand about human genetics, polymorphism, cancer gene, gene-, system- or disease-specific databases to solve real biological problems.

UNIT-V

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.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of database searches to retrieve the biological data from biological databases.
- Understand the principles of keyword and sequence based searches to retrieve the biological data from biological databases.
- Compare and contrast different keyword and sequence based searches.
- Describe about methods and online tools for sequence analysis.
- Interpretation of results from the analysis of sequence data, structural data as well as bibliographic databases.

Recommended Books:

1. Introduction to Bioinformatics – Arthur M. Lesk, 3rd Ed.
2. Bioinformatics and Functional Genomics – Jonathan Pevsner, 2nd Ed.
3. Essential Bioinformatics – JinXiong.

(MBI306P): GENOMICS AND PROTEOMICS LABORATORY

Genomics Laboratory

1. Acquaintance with Genomic databases.
2. Characterization of genomes.
3. Prediction of ORF for genomic/DNA sequences from prokaryotic origin.
4. Prediction of ORF for genomic/DNA sequences from eukaryotic origin.
5. Contig analysis and assembly
6. Genome assembly.

Proteomics Laboratory

1. Comparative analysis of protein samples using native and SDS-PAGE.
2. Demonstration of 2D-gel electrophoresis and analysis using 2DE databases.
3. Analysis of drug impurities using HPLC.
4. Prediction of post-translational modifications using various tools.
5. Predicting function of proteins using domain databases.
6. Identification of interacting partners using various Interaction maps.

(MBI307P): ADVANCED PROGRAMMING LABORATORY

DBMS LABORATORY

1. Data Definition Language (DDL) statements:
   - Creating database, selecting database, Deleting database
   - Creating table, Modifying Table, Deleting table

2. Data Manipulation statements:

   - Inserting, updating and deleting records
   - Retrieving Records, Retrieving specific rows and columns
   - Use of My SQL operators – Arithmetic operators, Comparison Operators, Logical operators

JAVA & BIOJAVA PROGRAMMING LABORATORY

1. Simple java program.
2. Java program to implement simple-if, if-else, if-else-ladder, nested-if.
3. Java program to identify even or odd number.
4. Java program to identify largest or smallest number in an array.
5. Java program for concatenation.
6. Java program for transcription.
7. Java program for reverse complement.
8. Java program for calculation GC content.

BIOPERL PROGRAMMING LABORATORY

1. Perl program to concatenate 2 strings.
2. Perl program to find motif.
3. Perl program for transcription.

(MBI401): DRUG DESIGNING AND NANOTECHNOLOGY

Course Objectives

- To let students to understand the use of informatics in drug design and development, finding new targets to treat disease; mechanism of drug designing
- To provide brief idea of various drug targets and their mechanisms of action
- To understand the concept of nanotechnology, methods and applications

UNIT-I

Introduction to Drugs: Drug discovery and Design – A historical outline, Sources of leads and drugs, Classification of drugs, Drug properties, barriers, solubility and permeability, ADMET properties. Drug administration and dosing, Bioavailability.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the historical outline of drugs evolution.
- Explain about sources of various drugs, their classification and properties.
- Describe the ADMET properties and their importance in drug designing studies.

UNIT-II

Introduction to Drug targets: Properties and types of drug targets – Enzymes, Receptors, DNA, RNA, Transport proteins, Structural proteins, Lipids, Carbohydrates.

Learning Outcomes:
By the end of this unit, the student will be able to

- Describe the types of drug targets, their properties with their mechanisms of action.

UNIT-III

Types of drug design: Traditional drug design, Rational drug design, Steps in Modern drug design cycle, Target identification strategies, Target validation methods, Lead identification through screening approaches – High Throughput Screening (HTS), Virtual Screening (VS) strategies.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the major types of drug designing methods.
- Explain the steps involved in modern drug discovery.
- Describe the various screening techniques employed in drug designing.

UNIT-IV

SBDD: Molecular docking: Steps, Methods of docking, Search algorithms and Scoring functions. LBDD: Lead optimization methods – Pharmacophore identification, Structure Activity Relationship (SAR), Drug Metabolism and PharmacoKinetics (DMPK) parameters.

QSAR: Parameters, Descriptors, Analysis and Case study, 3D-QSAR, Pre-clinical studies, Clinical trials and FDA approval.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the principles behind docking, its algorithms and methods..
- Describe the various lead optimization methods used in drug designing studies.
- Explain the QSAR methodology and its application in LBDD.
- Describe the types of clinical details and role of FDA approval.

UNIT-V

Nanobiotechnology: Nanoparticles – metal based, lipid based and polymer based. Properties of nanoparticles and routes of administration.Role of nanosized carriers and nanoparticles in drug delivery.Nanotubes and nanowires.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the principles of nanobiotechnology and its application in medicine.
- Describe the various types of nanoparticles.
- Explain the methods of nano-based drug delivery.

Recommended Books:

1. An Introduction to Medicinal Chemistry – Graham L. Patrick, 5th edition, Oxford
2. Medicinal Chemistry – Gareth Thomas, 2nd Ed.
3. Computational Drug Design – David C.Young.
4. Lead Generation Approaches in Drug Discovery – Zoran & Richard, Wiley.
5. Chemoinformatics in Drug Discovery, Tudor, Vol. 23, Wiley.
6. Foye's Principles of Medicinal Chemistry – Lemke and Williams, 6th Ed.

(MBI402A): CANCER BIOLOGY AND CANCER INFORMATICS

Course Objectives

- To understand concept, mechanisms, role of genes, pathways, and other molecules in manifestation of cancer.
- To understand about tumor antigens and immunological surveillance of cancer and also about the therapies related to cancer.
- To understand the methodologies and principles to analyze the genome of cancer.
- To understand the concept of epigenetic mechanism regulating gene expression profile of tumors; and also the methodologies to capture epigenetic mechanism.
- To, understand the concept and principles of biomarker, pharmacogenomics, precision medicine, and personalized medicine; and their role in cancer research.

UNIT - I

General characteristics and types of cancer.Mechanism of chemical radiation and viral induced carcinogenesis. oncogenes (c-Myc) and tumor suppressor genes (p53). mechanism of metastasis, apoptosis and angiogenesis, Epigenetics – DNA methylation and histone modification. Key signalling networks – Wnt, notch and hedgehog signalling.The impact of microRNAs, ultra-conserved long non-coding RNAs and environment on cancer.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of cancer and their types.
- Explain the mechanism of metastasis, apoptosis and angiogenesis in carcinogenesis.
- Describe the role of oncogenes and tumor suppressor genes
- Understands the role and implications of epigenetics mechanism and key signaling networks in cancer.
- Describes the impact of microRNAs, ultra-conserved long non-coding RNAs and environment on cancer.

UNIT - II

Tumor Immunology – Tumor antigens, immunological surveillance of cancer. Cancer therapy - Principles and mode of action of chemotherapy, Radiotherapy, immunotherapy, gene therapy and Stem cell therapy.

Learning Outcomes:
By the end of this unit, the student will be able to

- Explains about tumor antigens and immunological surveillance of cancer.
- Describe the principles and mode of action of chemotherapy, radiotherapy, immunotherapy, gene therapy and Stem cell therapy on cancer.

UNIT - III

Cancer Genome Analysis: Cancer Genome Atlas (TCGA), International Cancer Genome Consortium (ICGC), Reciprocal Subtraction Differential RNA Display (RSDD), Rapid Subtraction Hybridization (RaSH), Differential Display as a Gene Profiling Tool.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the methodologies to analyze the genome of cancer.
- Explain about the role of Cancer Genome Atlas (TCGA) and International Cancer Genome Consortium (ICGC) in cancer research.
- Describe the principles behind RSDD, RaSH, Differential Display as a Gene Profiling Tool in understanding cancer.

UNIT - IV

Gene Expression Profile of Tumors, Tissue micro-arrays (breast, ovarian),cDNA Microarray and Bioinformatics Analysis, Complete Open Reading Frame (C-ORF) Technique. Chromatin Immunoprecipitation Assays: Artificial Chromosome Transfection, Monitoring Methylation and Gene Expression in Cancer.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the methodologies of genome analysis of cancer.
- Understand the concept of gene expression profile of tumors.
- Describe the principles behind Chromatin Immunoprecipitation Assays to understand cancer.
- Describes the role and monitoring of methylation and gene expression in cancer.

UNIT - V

SNPs, Next generation sequencing (DNA & RNA), Genome-Exome panels, serum panels, Biomarker discovery through genomics, Pharmacogenomics, precision medicine.personalized medicine.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of SNP and its role in cancer.
- Explain about the scope of next generation sequencing and their role in cancer research.
- Describe the principles behind genome-exome panels, serum panels and their role in cancer research.
- Describe about biomarker discovery through genomics and their role in cancer research.
- Illustrate about pharmacogenomics, precision medicine, and personalized medicine.

Recommended Books:

1. Cancer Genomics and Proteomics: Methods and Protocols by, Paul B. Fisher Eds.
2. Cancer Genomics, From Bench to Personalized Medicine by Dellaire, Berman Arceci, Eds, Academic Press, 2013.

Course Objectives

- To understand the scope and types of bioinformatics algorithms to solve real biological problems.
- To describe the principles behind dynamic programming in finding the longest common subsequence & longest increasing subsequence.
- To describe the principles behind algorithms - exhaustive search, branch-and-bound algorithms, greedy algorithms, divide-and-conquer algorithms, machine learning, randomized algorithms.
- To understand the principles behind algorithms on searching and sorting.
- To understand the concept and principles of graph algorithms.

UNIT- 1

Introduction to Bioinformatics algorithms, types - Dynamic Programming, Exhaustive Search, Branch-and-Bound Algorithms.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of bioinformatics algorithms to solve real biological problems.
- Explain about the scope and types of bioinformatics algorithms.
- Describe the principles behind algorithms - dynamic programming, exhaustive search, branch-and-bound algorithms.

UNIT -II

Greedy Algorithms, Divide-and-Conquer Algorithms, Machine Learning, Randomized Algorithms.

Learning Outcomes:
By the end of this unit, the student will be able to

- Describe the principles behind algorithms - greedy algorithms, divide-and-conquer algorithms, machine learning, randomized algorithms.

UNIT-III

Dynamic programming - Longest Common Subsequence & Longest Increasing Subsequence.

Learning Outcomes:
By the end of this unit, the student will be able to

- Describe the principles behind dynamic programming in finding the longest common subsequence & longest increasing subsequence.

UNIT-IV

Searching and Sorting - Binary Search, Quick Sort, Merge Sort, KMP algorithm, Counting Sort, Data Structures: Binary Indexed Tree, Segment Tree, Tries.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understands the principles behind algorithms on searching and sorting.
- Describe the principles behind search, sort, tree, tries algorithms.
- Compare and contrast algorithms of tree and tries.

UNIT-V

Graph algorithms: Dijkstra algorithms - Shortest Path from source to all vertices, Prim algorithms - Minimum Spanning tree, Kruskal algorithms - Minimum Spanning tree.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept and principles of graph algorithms.

Recommended books:

1. An Introduction to Bioinformatics Algorithms, Pevsner, Neil C. Jones and Pavel A. Pevzner, MIT Press, 2004.
2. Introduction to Algorithms, Thomas H. Cormen, MIT Press; third edition edition.
3. Algorithms in Bioinformatics: A Practical Introduction, Wing-Kin Sung, Chapman and Hall/CRC.

(MBI402C): STEM CELL BIOLOGY AND REGENERATIVE MEDICINE

Course Objectives:

- Learn the various types of stem cells, their identification, isolation and cultural techniques.
- To learn the applications of cord blood stem cells in treating various dieases.And understand the concept of stem cell niche and its importance
- To learn stem cell cycle regulation and explore various animal models used in stem cell research.
- To learn about stem cell transplantation and explore recent advances and challenges in pluripotent stem cell research.
- To learn various methods of gene therapy and its applications.
- To learn about translational research and its applications in the treatment of diabetes and prostate cancer.
- To learn about cancer stem cells and study the various cell signalling pathways up regulated in cancer stem cells.
- To study the mechanisms oftissue regeneration in the treatment of Myocardial infarction.
- To explore the recent advances in the application of regenerative technologies to combat and overcome problems associated with ageing- Parkinson's disease.

UNIT - I

Stem cell Biology: Characteristic features of stem cells. Types – Embryonic, adult and Umbilical cord blood stem cells. Identification and culture of embryonic and adult stem cells.Isolation of embryonic stem cells from cord blood and their preservation. Stem cell niche. Role of stem cells in the treatment of diabetes.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the various types of stem cells their identificationand isolation.
- Learn stem cell cultural techniques and establishment of stem cell lines.
- Understand the concept of stem cell niche and its importance.
- Study the applications of cord blood stem cells in treating various dieases.

UNIT – II

Isolation and characterization of stem cells-Localization of adult stem cells in various tissues-Hematopoietic, mesenchymal, neural, cardiac and muscle. Stem cell markers. Mechanism of stem cell self renewal and differentiation. Culture and maintenance of stem cells in vitro.Animal models in stem cell research. Stem cell cycle regulation.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the isolation and characterization of stem cells.
- Localization of adult stem cells and their identification.
- Understandabout stem cell cycle regulation.
- Explore various animal models used in stem cell research.

UNIT-III

Stem cell therapy- Autologous and allogenic stem cell transplantation, HLA typing. Gene therapy using stem cells: Methods of gene therapy. Applications of stem cells in gene therapy. Tissue derivation from different germ layers.Significance of pluripotency. Induced pluripotency of stem cells. Recent advances, applications and challenges in the production of pluripotent stem cells.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn about autologous and allogenic stem cell transplantation.
- Learn various methods of gene therapy and its applications.
- Explore recent advances and challenges in pluripotent stem cell research.

UNIT-IV

Translational research- Overview and phases of translational research.Importance of translational research in diabetes and prostate cancer.Origin of cancer stem cells and their role in tumor recurrence and relapse of breast cancer and prostate cancer. Cell signalling pathways upregulated in cancer stem cells,

Learning Outcomes:
By the end of this Unit, the student will be able to

- Understand about translational research and various phases involved in it.
- Explore the applications of translational research in diabetes and prostate cancer.
- Learn about cancer stem cells their identification and isolation.
- Study the various cell signalling pathways upregulated in cancer stem cells

UNIT-V

Regenerative medicine: Concept and overview of regenerative medicine. Mechanisms underlying the regeneration of tissues in the treatment of Myocardial infarction Applications of regenerative technologies to combat and overcome problems associated with ageing- Parkinson's disease.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn about concepts of regenerative medicine.
- Study the mechanisms of regeneration of tissues in the treatment of Myocardial infarction various Immune techniques.
- Explore the recent advances in the application of regenerative technologies to combat and overcome problems associated with ageing- Parkinson's disease.

Recommended Books:

1. Stem cell biology and Gene therapy, Peter J QuesenBerryr, Willey – Less.
2. Essentials of Stem Cell Biology by Robert Lanza and Anthony Atala, Elsevier
3. Stem Cells: From Basic Research to Therapy, Volume 1: Basic Stem Cell Biology, Tissue Formation during Development, and Model Organisms by Federico Calegari, Claudia Waskow, Taylor and Francis group.

(MBI403P): DRUG DESIGNING LABORATORY

1. Target Prediction
2. Binding Site Prediction.
3. Structure based Virtual Screening.
4. Ligand based Virtual Screening.
5. Protein-Ligand Docking.
6. Protein-Protein Docking.
7. Antigen-Antibody Docking.
8. QSAR Databases.
9. QSAR Model Generation.
10. ADMET Databases
11. ADMET Prediction.
12. Toxicity Prediction.

(MBI404P): PROJECT WORK AND SEMINAR