



**ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION**

**Programme: B.Sc. Honours in Bioinformatics (Major)**

**w.e.f. AY 2023-24**

**COURSE STRUCTURE**

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits		
I	I	1	Introduction to Classical Biology	3+2	4		
		2	Introduction to Applied Biology	3+2	4		
	II	3		Cell Biology and Microbiology	3	3	
				Cell Biology and Microbiology Practical Course	2	1	
		4		Biomolecules	3	3	
				Biomolecules Practical Course	2	1	
II	III	5	Basics of Computer application inBiology	3	3		
			Basics of Computer application inBiology Practical Course	2	1		
		6		Fundamentals of Mathematics and Statistics	3	3	
				Fundamentals of Mathematics and Statistics Practical Course	2	1	
		7		Molecular Biology	3	3	
				Molecular Biology Practical Course	2	1	
		8		Genetic Engineering	3	3	
				Genetic Engineering Practical Course	2	1	
		IV	9		Genomics and Proteomics	3	3
					Genomics and Proteomics Practical Course	2	1
			10		Programming in C	3	3
				Programming in C Practical Course	2	1	
	11		Chemoinformatics	3	3		
			Chemoinformatics Practical Course	2	1		
	III	V	12	Structural Bioinformatics	3	3	
Structural Bioinformatics Practical Course				2	1		
13				Programming in Pearl	3	3	
				Programming in Pearl Practical Course	2	1	
14				Visual Basic and Net Banking	3	3	
				Visual Basic and Net Banking Practical Course	2	1	
15				Biodiversity and Biodiversityinformatics	3	3	
				Biodiversity and Biodiversityinformatics Practical Course	2	1	
VI		Semester Internship/Apprenticeship with 12 Credits					
IV		VII	16 A	Advanced Molecular Biology	3	3	
	Advanced Molecular Biology Practical Course			2	1		
	<b>OR</b>						
	16 B			Advances in Structural Informatics	3	3	
				Advances in Structural Informatics Practical Course	2	1	

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits		
		17 A	Molecular Genetics	3	3		
			Molecular Genetics Practical Course	2	1		
		<b>OR</b>					
		17 B	Systems Biology	3	3		
			Systems Biology Practical Course	2	1		
		18 A	Biostatistics and Applications	3	3		
			Biostatistics and Applications Practical Course	2	1		
		<b>OR</b>					
		18 B	Bioinformatics Algorithms	3	3		
			Bioinformatics Algorithms Practical Course	2	1		
		<b>SEC</b>					
		19 A	Biological Modeling	3	3		
			Biological Modeling Practical Course	2	1		
		<b>OR</b>					
		19 B	Mathematical Approaches in Biology	3	3		
			Mathematical Approaches in Biology Practical Course	2	1		
		20 A	Pharmacoinformatics	3	3		
			Pharmacoinformatics Practical Course	2	1		
	<b>OR</b>						
	20 B	Database Management and Implementation	3	3			
		Database Management and Implementation Practical Course	2	1			
	21 A	Immunology	3	3			
		Immunology Practical Course	2	1			
	<b>OR</b>						
	21 B	Medical and Health informatics	3	3			
		Medical and Health informatics Practical Course	2	1			
	22 A	Virology	3	3			
		Virology Practical Course	2	1			
	<b>OR</b>						
	22 B	Cancer Biology	3	3			
		Cancer Biology Practical Course	2	1			
	23 A	Drug Discovery and Drug Design	3	3			
Drug Discovery and Drug Design Practical Course		2	1				
<b>OR</b>							
23 B	Molecular and Cellular Techniques	3	3				
	Molecular and Cellular Techniques Practical Course	2	1				
<b>SEC</b>							
24 A	Immunoinformatics	3	3				
	Immunoinformatics Practical Course	2	1				
<b>OR</b>							
24 B	Python Programming	3	3				
	Python Programming Practical Course	2	1				
25 A	Patenting and IPR	3	3				
	Patenting and IPR Practical Course	2	1				
VIII	21 A	Immunology	3	3			
		Immunology Practical Course	2	1			
	<b>OR</b>						
	21 B	Medical and Health informatics	3	3			
		Medical and Health informatics Practical Course	2	1			
	22 A	Virology	3	3			
		Virology Practical Course	2	1			
	<b>OR</b>						
	22 B	Cancer Biology	3	3			
		Cancer Biology Practical Course	2	1			
	23 A	Drug Discovery and Drug Design	3	3			
		Drug Discovery and Drug Design Practical Course	2	1			
	<b>OR</b>						
	23 B	Molecular and Cellular Techniques	3	3			
Molecular and Cellular Techniques Practical Course		2	1				
<b>SEC</b>							
24 A	Immunoinformatics	3	3				
	Immunoinformatics Practical Course	2	1				
<b>OR</b>							
24 B	Python Programming	3	3				
	Python Programming Practical Course	2	1				
25 A	Patenting and IPR	3	3				
	Patenting and IPR Practical Course	2	1				

<b>Year</b>	<b>Semester</b>	<b>Course</b>	<b>Title of the Course</b>	<b>No. of Hrs /Week</b>	<b>No. of Credits</b>
		<b>OR</b>			
		25 B	Research Methodology	3	3
			Research Methodology Practical Course	2	1

## SEMESTER-I

### COURSE 1: INTRODUCTION TO CLASSICAL BIOLOGY

Theory

Credits: 4

5 hrs/week

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#### Learning objectives

The student will be able to learn the diversity and classification of living organisms and understand their chemical, cytological, evolutionary and genetic principles.

#### Learning Outcomes

1. Learn the principles of classification and preservation of biodiversity
2. Understand the plant anatomical, physiological and reproductive processes.
3. Knowledge on animal classification, physiology, embryonic development and their economic importance.
4. Outline the cell components, cell processes like cell division, heredity and molecular processes.
5. Comprehend the chemical principles in shaping and driving the macromolecules and life processes.

#### Unit 1: Introduction to systematics, taxonomy and ecology.

- 1.1. Systematics – Definition and concept, Taxonomy – Definition and hierarchy.
- 1.2. Nomenclature – ICBN and ICZN, Binomial and trinomial nomenclature.
- 1.3. Ecology – Concept of ecosystem, Biodiversity and conservation.
- 1.4. Pollution and climate change.

#### Unit 2: Essentials of Botany.

- 2.1. The classification of plant kingdom.
- 2.2. Plant physiological processes (Photosynthesis, Respiration, Transpiration, phytohormones).
- 2.3. Structure of flower – Micro and macro sporogenesis, pollination, fertilization and structure of mono and dicot embryos.
- 2.4 Mushroom cultivation, floriculture and landscaping.

#### Unit 3: Essentials of Zoology

- 3.1. The classification of Kingdom Animalia and Chordata.
- 3.2 Animal Physiology – Basics of Organ Systems & their functions, Hormones and Disorders
- 3.3 Developmental Biology – Basic process of development (Gametogenesis, Fertilization, Cleavage and Organogenesis)
- 3.4 Economic Zoology – Sericulture, Apiculture, Aquaculture

#### Unit 4: Cell biology, Genetics and Evolution

- 4.1. Cell theory, Ultrastructure of prokaryotic and eukaryotic cell, cell cycle.
- 4.2. Chromosomes and heredity – Structure of chromosomes, concept of gene.
- 4.3. Central Dogma of Molecular Biology.

#### 4.4. Origin of life

### **Unit 5: Essentials of chemistry**

5.1. Definition and scope of chemistry, applications of chemistry in daily life.

5.2. Branches of chemistry

5.3. Chemical bonds – ionic, covalent, noncovalent – Vander Waals, hydrophobic, hydrogen bonds.

5.4. Green chemistry

### **References**

1. Sharma O.P., 1993. Plant taxonomy. 2<sup>nd</sup> Edition. McGraw Hill publishers.
2. Pandey B.P., 2001. The textbook of botany Angiosperms. 4<sup>th</sup> edition. S. Chand publishers, New Delhi, India.
3. Jordan E.L., Verma P.S., 2018. Chordate Zoology. S. Chand publishers, New Delhi, India.
4. Rastogi, S.C., 2019. Essentials of animal physiology. 4<sup>th</sup> Edition. New Age International Publishers.
5. Verma P.S., Agarwal V.K., 2006. Cell biology, genetics, Molecular Biology, Evolution and Ecology. S. Chand publishers, New Delhi, India.
6. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4<sup>th</sup> Edition. Elsevier publishers.
7. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
8. Karen Timberlake, William Timberlake, 2019. Basic chemistry. 5<sup>th</sup> Edition. Pearson publishers.
9. Subrata Sen Gupta, 2014. Organic chemistry. 1<sup>st</sup> Edition. Oxford publishers.

### **ACTIVITIES:**

1. Make a display chart of life cycle of nonflowering plants.
2. Make a display chart of life cycle of flowering plants.
3. Study of stomata
4. Activity to prove that chlorophyll is essential for photosynthesis
5. Study of pollen grains.
6. Observation of pollen germination.
7. Ikebana.
8. Differentiate between edible and poisonous mushrooms.
9. Visit a nearby mushroom cultivation unit and know the economics of mushroom cultivation.

10. Draw the Ultrastructure of Prokaryotic and Eukaryotic Cell
11. Visit to Zoology Lab and observe different types of preservation of specimens
12. Hands-on experience of various equipment – Microscopes, Centrifuge, pH Meter, Electronic Weighing Balance, Laminar Air Flow
13. Visit to Zoo / Sericulture / Apiculture / Aquaculture unit
14. List out different hormonal, genetic and physiological disorders from the society

## SEMESTER-I

### COURSE 2: INTRODUCTION TO APPLIED BIOLOGY

Theory

Credits: 4

5 hrs/week

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#### **Learning objectives**

The student will be able to learn the foundations and principles of microbiology, immunology, biochemistry, biotechnology, analytical tools, quantitative methods, and bioinformatics.

#### **Learning Outcomes**

1. Learn the history, ultrastructure, diversity and importance of microorganisms.
2. Understand the structure and functions of macromolecules.
3. Knowledge on biotechnology principles and its applications in food and medicine.
4. Outline the techniques, tools and their uses in diagnosis and therapy.
5. Demonstrate the bioinformatics and statistical tools in comprehending the complex biological data.

#### **Unit 1: Essentials of Microbiology and Immunology**

- 1.1. History and Major Milestones of Microbiology; Contributions of Edward Jenner, Louis Pasteur, Robert Koch and Joseph Lister.
- 1.2. Groups of Microorganisms – Structure and characteristics of Bacteria, Fungi, Archaea and Virus.
- 1.3. Applications of microorganisms in – Food, Agriculture, Environment, and Industry.
- 1.4. Immune system – Immunity, types of immunity, cells and organs of immune system.

#### **Unit 2: Essentials of Biochemistry**

- 2.1. Biomolecules I – Carbohydrates, Lipids.
- 2.2. Biomolecules II – Amino acids & Proteins.
- 2.3. Biomolecules III – Nucleic acids -DNA and RNA.
- 2.4. Basics of Metabolism – Anabolism and catabolism.

#### **Unit 3: Essentials of Biotechnology**

- 3.1. History, scope, and significance of biotechnology. Applications of biotechnology in Plant, Animal, Industrial and Pharmaceutical sciences.
- 3.2. Environmental Biotechnology – Bioremediation and Biofuels, Biofertilizers and Biopesticides.
- 3.3. Genetic engineering – Gene manipulation using restriction enzymes and cloning vectors; Physical, chemical, and biological methods of gene transfer.
- 3.4. Transgenic plants – Stress tolerant plants (biotic stress – BT cotton, abiotic stress – salt tolerance). Transgenic animals – Animal and disease models.

#### **Unit 4: Analytical Tools and techniques in biology – Applications**

- 4.1. Applications in forensics – PCR and DNA fingerprinting
- 4.2. Immunological techniques – Immunoblotting and ELISA.
- 4.3. Monoclonal antibodies – Applications in diagnosis and therapy.
- 4.4. Eugenics and Gene therapy

#### **Unit 5: Biostatistics and Bioinformatics**

- 5.1. Data collection and sampling. Measures of central tendency – Mean, Median, Mode.
- 5.2. Measures of dispersion – range, standard deviation and variance. Probability and tests of significance.
- 5.3. Introduction, Genomics, Proteomics, types of Biological data, biological databases- NCBI, EBI, Gen Bank; Protein 3D structures, Sequence alignment
- 5.4. Accessing Nucleic Acid and Protein databases, NCBI Genome Workbench

#### **REFERENCES**

1. Gerard J., Tortora, Berdell R. Funke, Christine L. Case., 2016. Microbiology: An Introduction. 11<sup>th</sup> Edition. Pearson publications, London, England.
2. Micale, J. Pelczar Jr., E.C.S. Chan., Noel R. Kraig., 2002. Pelczar Microbiology. 5<sup>th</sup> Edition. McGraw Education, New York, USA.
3. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4<sup>th</sup> Edition. Elsevier publishers.
4. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
5. R.C. Dubey, 2014. Advanced Biotechnology. S. Chand Publishers, New Delhi, India.
6. Colin Ratledge, Bjorn, Kristiansen, 2008. Basic Biotechnology. 3<sup>rd</sup> Edition. Cambridge Publishers.
7. U. Sathyanarayana, 2005. Biotechnology. 1<sup>st</sup> Edition. Books and Allied Publishers pvt. ltd., Kolkata.
8. Upadhyay, Upadhyay and Nath. 2016. Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.
9. Arthur M. Lesk. Introduction to Bioinformatics. 5<sup>th</sup> Edition. Oxford publishers.
10. AP Kulkarni, 2020. Basics of Biostatistics. 2<sup>nd</sup> Edition. CBS publishers.

#### **ACTIVITIES**

1. Identification of given organism as harmful or beneficial.
2. Observation of microorganisms from house dust under microscope.
3. Finding microorganism from pond water.



4. Visit to a microbiology industry or biotech company.
5. Visit to a waste water treatment plant.
6. Retrieving a DNA or protein sequence of a gene'
7. Performing a BLAST analysis for DNA and protein.
8. Problems on biostatistics.
9. Field trip and awareness programs on environmental pollution by different types of wastes and hazardous materials.
10. Demonstration on basic biotechnology lab equipment.
11. Preparation of 3D models of genetic engineering techniques.
12. Preparation of 3D models of transgenic plants and animals.

[**NOTE:** In the colleges where there is availability of faculty for microbiology and biotechnology, those chapters need to be handled by microbiology and biotechnology faculty. In other colleges, the above topics shall be dealt by Botany and Zoology faculty]

## SEMESTER-II

### COURSE 3: CELL BIOLOGY AND MICROBIOLOGY

Theory

Credits: 3

3 hrs/week

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#### I Learning Objectives:

1. To acquaint students with basic concepts of Cell Biology
2. To complement students with knowledge on chromosome structure and packaging.
3. To enable them learn concepts of Microorganisms and their growth aspects

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Explain cells structure of prokaryotes and eukaryotes
2. Illustrate stages of mitosis, meiosis and structure and organization of chromosomes
3. Learn classification of microorganisms, basic structure of bacteria and viruses
4. Perform sterilization of microbial media and narrate microbial growth
5. Narrate simple and differential methods of identification of bacteria

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

##### Cell Biology:

1. Cell as a basic unit of life.
2. Cell organization of prokaryotic and eukaryotic cells.
3. Structural and functional capitalization of cell:– Mitochondria, Chloroplast, Lysosomes, Golgibodies, Plasma membrane, Cytoskeleton, Cell wall and Nucleus.

##### Unit 2:

1. Cell cycle, cell division - mitosis and meiosis.
2. Chromosome structure, gene, gene number, gene clusters and Pseudogene.
3. Polytene and lamp brush chromosomes.
4. Packing of DNA, supercoiled DNA, nucleosome.
5. Inverted repeats, repetitive DNA sequence, satellite DNA

##### Unit 3:

##### Microbiology:

1. Introduction to Microbiology and microbial diversity
2. Classification of microorganisms.
3. Bacterial structure and reproduction
4. Introduction to viruses- plant and animal viruses- structure and life cycle

##### Unit 4:

1. Sterilization-Application of sterilization methods in biotechnology, Various sterilization methods, Microbial contamination control and Sterility testing.
2. Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture.

**Unit 5:**

1. Principles of microscopy – Light microscopy, Bright field and Electron microscopy (SEM and TEM).
2. Staining Techniques - Simple and Differential staining techniques.
3. Direct methods for measuring microbial growth: viable plate counts, membrane filtration. Indirect methods: Metabolic activity – measurements of DNA, Protein, Microscopic counts, electronic counters, most probable number

## SEMESTER-II

### COURSE 3: CELL BIOLOGY AND MICROBIOLOGY

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Work with microscopes and observe plants cell to microorganisms
2. Isolate cell organelles from plant cells
3. Culture bacteria and fungi in culture media
4. Perform sterilization of media
5. Identify stages of mitosis and meiosis from biological samples

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Microbiology Good Laboratory Practices and Biosafety.
2. Preparation of culture media for cultivation of bacteria
3. Preparation of culture media for cultivation of fungi
4. Sterilization of medium using Autoclave
5. Sterilization of glassware using Hot Air Oven
6. Light compound microscope and its handling
7. Study of mitosis on onion root tips
8. Study of meiosis on onion buds
9. Isolation and separation of cell organelles from plant cell.
10. Study of growth curve of *E.coli*

#### VI. References:

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (1993). Microbiology. 5th Edition, Tata Mc Graw Hill Publishing Co., Ltd., New Delhi.
2. Dube, R.C. and Maheswari, D.K. (2000) General Microbiology. S Chand, New Delhi. Himalaya Publishing House, Mumbai.
3. Power, C.B. and Dagainawala, H.F. (1986). General Microbiology Vol I & II
4. Prescott, M.J., Harley, J.P. and Klein, D.A. (2010). Microbiology. 5th Edition, WCB Mc Graw Hill, New York.
5. Reddy, S.M. and Reddy, S.R. (1998). Microbiology Practical Manual, 3 rd Edition, Sri Padmavathi Publications, Hyderabad.
6. Singh, R.P. (2007). General Microbiology. Kalyani Publishers,
7. Stanier, R.Y., Adelberg, E.A. and Ingram, J.L. (1991). General Microbiology, 5th Ed., Prentice New Delhi.Hall of India Pvt. Ltd., New Delhi.
8. Microbiology Edited by Prescott
9. Jaya Babu (2006). Practical Manual on Microbial Metabolisms and General Microbiology. Kalyani Publishers, New Delhi.
10. Gopal Reddy *et al.*, Laboratory Experiments in Microbiology

#### VII. Co-Curricular Activities

##### Suggested Co-Curricular Activities

1. Training of students by related aspects using pure cultres

2. Assignments on handling microscopic techniques with safety and precautions)
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on tools and techniques on mitosis and meiosis
5. Collection of material/figures/photos related to stages of cell division, microbial growth curve and staining methods.
6. Visits to advanced laboratories to get exposure to SEM and TEM
7. Invited lectures and presentations on related topics by experts.

**SEMESTER-II**  
**COURSE 4: BIOMOLECULES**

Theory

Credits: 3

3 hrs/week

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**I Learning Objectives:**

1. To enable students learn classification, structure and properties of biomolecules
2. To enhance knowledge on protein types and their structural organization
3. To complement knowledge on peptide synthesis and structure prediction

**II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Classify and characterize carbohydrates
2. Narrate the structure and properties of amino acids and proteins
3. Explain structural organization of proteins
4. Illustrate protein synthesis and evolution prediction
5. Describe the structure and composition of nucleic acids

**III. Syllabus: (Total Teaching Hours: 45)**

**Unit 1:**

**Classification, Structures and Carbohydrate Metabolism:**

1. Classification, characteristics and functions of monosaccharides, disaccharides - polysaccharides.
2. Epimers, isomers, anomers, chiral carbon atom, chair and boat form, glucopyranose and fructopyranose.
3. Carbohydrate metabolism- Glycolysis - aerobic and anaerobic, regulation of glycolysis. Krebs cycle and its regulation; Hexose monophosphate shunt.

**Unit 2:**

**Amino Acids and Proteins:**

**Amino Acids:**

1. Chemical structure and general properties of amino acids, pI of amino acids, acid base concepts.
2. General metabolism scheme of amino acids and Urea cycle

**Proteins:**

1. Classification- size, shape, degree of association, complexity. Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural, defense and regulatory)
2. Structure of peptide bond - restricted rotation, cis - trans bending, Ramchandran plot. Peptides.

**Unit 3:**

**Protein structure:**

1. Secondary structure - alpha helix and beta pleated structure, triple helix (collagen) and Supersecondary structures.
2. Tertiary structure - forces stabilizing tertiary structure, unfolding/refolding experiment.
3. prediction of secondary and tertiary structure.
4. Dynamics of protein folding, role of molecular chaperones in protein folding,
5. Techniques for studying primary sequence of proteins, experimental methods, end group analysis, finger printing and sequenators

#### **Unit 4:**

##### **Protein synthesis and evolution analysis**

1. Chemical synthesis of peptides, solid phase automated synthesis.
2. Prediction of conformation from amino acid sequence.
3. Zymogens and their conversion into active proteins
4. Protein evolution - phylogenetic tree, convergent and divergent trees, sequence analysis, comparison matrix, Dot matrix and substitution matrix

#### **Unit 5:**

##### **Nucleic acids:**

1. Types of RNA and DNA- Structure of purines and pyrimidines, nucleosides, nucleotides. Stability and formation of phosphodiester linkages.
2. Effect of acids, alkali and nucleases on DNA and RNA.
3. Structure of Nucleic acids- Watson-Crick DNA double helix structure, denaturation and renaturation.

**SEMESTER-II**  
**COURSE 4: BIOMOLECULES**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Perform qualitative analysis of carbohydrates and amino acids
2. Conduct quantitative tests for DNA and RNA
3. Estimate reducing sugars and total sugars
4. Determine pI value for amino acids
5. Determine absorption spectrum for nucleic acids and proteins

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Qualitative Analysis of Carbohydrates.
2. Qualitative Analysis of Amino acids.
3. Colorimetric estimation DNA by diphenylamine method.
4. Estimation of RNA by Orcinol method.
5. Colorimetric estimation of proteins by Biuret / Lowry method.
6. Estimation of reducing sugar-Anthrone method.
7. Estimation of sugar by titration method–Benedict’s method.
8. Determination of pKa and pI values of amino acids.
9. Absorption spectrum, of nucleic acids
10. Absorption spectrum of BSA

**VI. References:**

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company Caldwell, D.R. (1995). Microbial Physiology and Metabolism, W.C. Brown Publications, Iowa, USA.
2. Lehninger, A.L., Nelson, D.L. and Cox, M.M. (1993). Principles of Biochemistry, 2 nd Edition, CBS Publishers and Distributors, New Delhi.
3. Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.
4. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
5. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
6. Proteins: Structure, function and evolution. Dickerson & Geis, 2nd Edn, Benjamin/Cummings.
7. Biochemistry - Zubay C, Addison – Wesley, 1986.
8. Biochemistry, A problem Approach, 2nd Edn. Wood, W.B. Addison Wesley 1981.

**VII. Co-Curricular Activities**

**Suggested Co-Curricular Activities**

1. Training of students in simple ways to analyze types of carbohydrates
2. Assignments protein structure determination and predictions
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on tools and techniques on biomolecules and their identification
5. Visit advanced labs and teach them determination of absorption spectrum of various biomolecules
6. Invite lectures and presentations on related topics by experts.



## SEMESTER-III

### COURSE 5: BASICS OF COMPUTER APPLICATION IN BIOLOGY

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. To obtain basic knowledge about computers and internet.
2. To develop the computational methods to utilize expression data's of cellular biology.
3. To study of the inherent structure of biological information.
4. To analyze the gene and protein sequences to reveal protein evolution.

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Identify components of computer
2. Connect to internet and email or download information
3. Understand basic history of bioinformatics
4. Illustrate about biological databses
5. Retrieve PDB formats of proteins from respective databases

#### **III. Syllabus: (Total Teaching Hours: 45)**

##### **Unit 1:**

##### **Computers –**

1. Characteristics of Computers – Areas of computer applications- I-P-O Cycle.
2. Components of Computers – Memory and control units-Input devices and output devices- Hardware and Software -Operating Systems.

##### **Unit 2:**

**Internet** –History of Internet-Uses of internet. Connection to Internet - Getting connection-Web page-Modem-Internet Service providers-E-mail and Voice Mail, Creating E-mail Address.

##### **Unit 3:**

**Introduction to bioinformatics** – history and its development – Scope and applications of bioinformatics

##### **Unit 4:**

**Biological database** – NCBI-GenBank, EMBL, DDBJ. Sequence Alignment-Pairwise (BLAST and FASTA) and Multiple sequence alignment (ClustalW).

##### **Unit 5:**

Structure of Protein, Classification –PDB, Swiss-PROT, SCOP, CATH. Protein visualization tools-RASMOL, Swiss PDB viewer.

## COURSE 5: BASICS OF COMPUTER APPLICATION IN BIOLOGY

Practical

Credits: 1

2 hrs/week

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### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Login computer and perform booting
2. Learn about operating systems
3. Retrieve data from databases
4. Perform emailing of retrieved data from databases
5. work with basics of pair wise alignment and multiple sequence alignment

### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Login operations of a computer and its characteristics
2. Hardware, software and booting of computers
3. Operating systems UNIX and LINUX
4. Emailing
5. Exposure to Databases- NCBI and DDBJ
6. Retrieve data from Databases
7. Pairwise alignment
8. Multiple sequence alignment

### VI. References:

1. Computer basic knowledge; hardware, connection, cables, typing, Windows98/XP, Internet browsers, search engines.
2. LAN connections, setting up the IP address, network security
3. Internet surfing and searching information, downloading and installing software
4. T.A.Attwood and D.J.Parry-smith, 2001, Introduction of Bioinformatics.
5. A.D.Baxevaris,1998, Bioinformatics: A practical guide to the analysis of Genes and proteins,(Edited) B.F.Publication.
6. David W, 2005, Bio-informatics; sequence and Genome Analysis, 2<sup>nd</sup> Edition By Mount CBS publishers

### VII. Co-Curricular Activities

#### Suggested Co-Curricular Activities

1. Training of students on working with computers
2. Help them know about booting and also operating systems in labs
3. Assignments on data retrieval and alignments studies
4. Groups discussion, quizzes and video making on basic concepts
5. Invited lectures on the course

## SEMESTER-III

### COURSE 6: FUNDAMENTALS OF MATHEMATICS AND STATISTICS

Theory

Credits: 3

3 hrs/week

#### I Learning Objectives:

1. To understand the basic mathematical concepts.
2. To gain knowledge about the Biostatistics.

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand the concepts of set and functions.
2. solve the problems of Matrices and acquire knowledge of different types of databases.
3. Apply the knowledge of statistics to organize the biological data.
4. Represent the biological data in charts and graphs format.
5. write the conclusions of their studies by using different statistical analysis tools

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

##### Sets and functions

1. Types of Sets, Subsets, Complement of Sets, union and Intersection of Sets,
2. Difference of Sets, .Demorgan's Law, Cartesian product of Set.
3. Relations and functions (out lines)

##### Unit 2:

##### Matrices, Determinants and Basics of Databases

1. Types of matrices, properties of matrices, addition, subtraction of matrices, matrix,multiplication, elementary transformation, inverse of matrices.
2. Determinants: - Definition, properties associated with determinants. Trigonometry and Derivatives.
3. Introduction Of Databases:-Concept of data, data models, data representation, mining, various types of databases, biological data and data analysis.
4. Related programs; Oracle, SQL, VB, Database management System (DBMS). Introduction to protein and nucleic acid databases

##### Unit 3:

##### Introduction to Biostatistics

1. Applications and uses, sample variable, statistical sampling,population,
2. Primary and secondary data, screening and representation of data.
3. Frequency distribution, bar diagram, histogram. Pie diagram, cumulative frequency cur Mean, median, mode, Comparison between mean, median and mode.
4. Measures of dispersion: range, variation, standard deviation, coefficient of variation, symmetry, probability distribution

##### Unit 4:

##### Probability, Correlation and Regression

1. Basics of Binomial, Poisson and Normal distributions and their application in biology.
2. Random Variable; Discrete and Continuous Probability Distribution, Probability mass function,

probability Density function,

3. Correlation and Regression: Types, Karl-Pearson's correlation, Spearman's Rank correlation,
4. Regression equation and fitting

### **Unit 5:**

#### **Statistical analysis**

1. Comparison of variance (F-test), small sample test, t-test for comparison of means, chisquare test.
2. Analysis of variance—one way and two way, multiple comprises
3. Sequence Analysis: Introduction to hidden Markov models.

## SEMESTER-III

### COURSE 6: FUNDAMENTALS OF MATHEMATICS AND STATISTICS

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Solve the problems of biological data with the interference of Biostatistics.
2. Organize the biological data by applying the knowledge of Biostatistics
3. Retrieve the required information from different biological data bases.
4. Comprehend the importance of Biostatistics
5. Perform T-test and Chi-square test

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Use of software for sequence analysis of nucleotides and proteins.
2. Problem related to t – test and  $\chi^2$  test.
3. Use of Internet/software for sequence analysis of nucleotides and proteins:
4. Studies of public domain data bases for nucleic acid and protein sequences.
5. Determination of protein structure (PDB)
6. Problems related to measures of central tendency,
7. T- test and chi-square test.

#### VI. References:

1. Daniel, 2006, Biostatistics, Eighth Edition. John Wiley and sons.
2. Durbin, Eddy, Krogh, Mithison, Biological sequence analysis.
3. T.A.AttwoodandD.J.parry-smith, 2001, Introduction of Bioinformatics.  
A.D.Baxevaris,1998, Bioinformatics: A practical guide to the analysis of Genes andproteins,(Edited)  
B.F.Publication

#### VII. Co-Curricular Activities

##### Suggested Co-Curricular Activities

1. Invited talks with subject experts in Biostatistics
  2. Assignment (related to application of Ststistics to solve problems of biological data)
  3. Seminars, Group discussions, Quiz, Debates etc
  4. Identification of different statistical softwares.
  5. Collection of data organization of data of some specific disease.
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## SEMESTER-III

### COURSE 7: MOLECULAR BIOLOGY

Theory

Credits: 3

3 hrs/week

#### I. Learning Objectives:

1. To know the structural organization of prokaryotic and eukaryotic genome.
2. To gain the knowledge of central dogma of Molecular biology.
3. To understand the concepts of regulation of Replication and Transcription

#### II. Learning Outcomes:

Students after successful completion of the course will be able to

1. Understand how the genome of prokaryotes and eukaryotes organized.
2. Gain the knowledge of Replication and repair process of DNA.
3. Appreciate the regulation process of replication, transcription and translation
4. know the mechanisms how antimicrobial agents inhibits replication, transcription and translation in bacteria.
5. understand the importance of protein folding and significance of chaperons

#### III. Syllabus: (Total Teaching hours- 45Hrs)

##### Unit : 1 - Genome Organization:

(10 h)

1. Organization of bacterial genome, Structure of eukaryotic chromosomes.
2. DNA denaturation and reassociation kinetics (Cot curve analysis),
- 3 Repetitive and unique sequences, kinetics and sequence complexities.
4. Satellite DNA, packing and organization of chromatin- nucleosome , solenoid and scaffold model , DNA methylation & Imprinting.

##### Unit : 2 –

##### Replication and Mutations:

(10 h)

1. Replication- Models of Replication (Rolling circle, )
2. Enzymes involved in replication: DNA Polymerases, Ligase, Topoisomerases, RNase H, Helicase,
3. Mechanism of replication in Prokaryotes and Eukaryotes, inhibitors of Replication.
4. Mutations- Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, physical, chemical mutagens.

##### Unit: 3

(10 h)

##### DNA Repair:

1. Gene Stability, DNA Repair- Enzymes involved in repair.
2. Types of Repair mechanisms- photoreactivation, nucleotide excision repair, mismatch correction, SOS repair.
3. Recombination:- homologous and non-homologous recombination, site specific recombination, Holliday structure, resolution, chi sequences in prokaryotes
4. Gene targeting, disruption, FLP/FRT and Cre/Lox recombination RecA and other recombinases.

##### Unit-4–Transcription:

(10 h)

1. Prokaryotic Transcription - Promoters, Regulatory elements, Transcription unit, constitutive and inducible promoter, operators, Initiation, Attenuation, Termination, Rho- dependent and independent termination,
2. Operon concept, Regulation of transcription of lac, trp, ara, his, and gal operons, transcriptional

control in lambda phage, Transcript processing.

3. Eucaryotic transcription : RNA polymerase structure and assembly, RNAPolymerase I, II, III, Eukaryotic promoters and enhancers, General Transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), Activators and repressors,transcription initiation, elongation and termination, activation and repression.

4. Post transcriptional Modifications : 3' Poly adenylation, 5' capping, splicing, RNA editing.

**Unit: 5 – Translation and Protein stability**

**(5 h)**

1. Genetic code- properties, Deciphering the Genetic code, Genetic code in Mitochondria and chloroplast.
2. Translation in Prokaryotes and Eukaryotes- intitation, elongation and termination.
3. Inhibitors of Protein synthesis(Mechanisms).
4. Signal hypothesis - Co and Post translational modifications..Protein turn over, Molecular chaperons.
5. Disorders associated with protein folding.

## SEMESTER-III

### COURSE 7: MOLECULAR BIOLOGY

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Identify the different types of DNA and RNA.
2. Perform the isolation of DNA from different biological samples.
3. Check the purity of DNA .
4. Get hands on experience to handle various instruments used in Molecular biology lab.
5. Solve the problems in replication and transcription with great ease.

#### V. Practical Syllabus: ( 2 hours per week total = 30 hours)

1. Study of different types of DNA and RNA using micrographs and model / schematic Representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from *E. coli*
4. Estimation of DNA using UV spectrophotometer.
5. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
6. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis(SDS - PAGE).
7. Problems related to DNA and RNA characteristics, Transcription and Translation.
8. Induction of mutations in bacteria by UV light.
9. Instrumentation in molecular biology - Ultra centrifuge, Transilluminator, PCR

#### VI. Co- curricular activities:

##### Suggested Co-curricular activities:

1. Visit the Molecular biology labs.
  2. Invited talks by subject experts and R&D People.
  3. Model preparation of DNA.
  4. Making of animations and videos of Replication , transcription and translation processes.
- Seminars, quiz, debate etc.,



## SEMESTER-III

### COURSE 8: GENETIC ENGINEERING

Theory

Credits: 3

3 hrs/week

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#### I Learning Objectives:

1. To enable students learn concepts of enzymes used in Genetic Engineering
2. To enhance knowledge on vector and gene transformation techniques
3. To enable them learn screening techniques of recombinant clones and PCR concepts

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Learn about restriction enzymes, their classes and Labelling of DNA
2. Categorize and use cloning vectors based on purpose
3. Narrate gene transfer methods
4. Explain methods of screening transformed cells and construction of cDNA libraries
5. Illustrate PCR and its applications

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

1. **Restriction analysis:** Types of restriction enzyme, Type I, II and III, restriction modifications systems, type II restriction endonucleases and properties, isoschizomers and neoschizomers, mcr/mrr genotypes, Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing.
2. **Labeling of DNA:** Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase.

##### Unit 2:

1. **Gene Cloning Vectors:** Plasmids, bacteriophages, Cloning in M13 mp vectors, phagemids, Lambda vectors. Cosmid vectors. Artificial chromosome vectors (YACs, BACs),
2. Animal Virus derived vectors- SV-40, vaccinia/baculo & retroviral vectors.
3. Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization.
4. DNA fingerprinting, chromosome walking & chromosome jumping.

##### Unit 3:

##### Insertion of Foreign DNA into Host Cells:

1. Transformation, Transfection.
2. Chemical and physical methods: liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection.
3. Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Riplasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors.
4. Cloning and expression in yeasts (*Saccharomyces*, *Pichia* etc.). Animal and plants cells.

##### Unit 4:

##### Selection and screening of clones

1. Methods of selection and screening, cDNA and genomic cloning, expression cloning, jumping and hopping libraries.

2. South western and far western cloning, yeast two hybrid system, phage display,
3. Construction of cDNA libraries in plasmids and screening methodologies, Construction of cDNA and genomic DNA libraries in lambda vector.
4. Principles in maximizing gene expression, Site-directed mutagenesis.

**Unit 5:**

**PCR and applications**

**1. PCR** - Primer design, Fidelity of thermostable enzymes, DNA polymerases, multiplex, nested, reverse transcriptase, real time PCR.

**2. Applications:**

PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis.

**SEMESTER-III**  
**COURSE 8: GENETIC ENGINEERING**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Isolate plasmid DNA from bacterial cells
2. Perform construction of recombinant plasmids using restriction digestion and ligation
3. Transform recombinant plasmids and securitize the transformed cells
4. Perform Blotting techniques
5. Illustrate about working of PCR

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Isolation of Plasmid DNA from E.coli
2. Transformation in Bacteria using plasmid.
3. Restriction digestion of DNA and its electrophoretic separation.
4. Ligation of DNA molecules and their testing using electrophoresis.
5. Activity of DNAase and RNAse on DNA and RNA.
6. Demonstration of PCR.
7. Electrophoretic separation of DNA fragments on agarose gel
8. Demonstration of southern blotting technique.
9. Demonstration of SDS – PAGE.
10. Calcium chloride mediated transfection

**VI. References:**

1. Gene Cloning & DNA Analysis: An Introduction (T.A.Brown, Blackwell).
2. Principles of Gene Manipulation: 2. An Introduction to Genetic Engineering (R.W.Old, & S.B. Primrose, Blackwell).
3. Molecular Biology, Genetic Engineering and Applications of Biotechnology (B.D.Singh, Kalyani Publishers)
4. Genes and Probes, A Practical Approach Series (1995) by Hames and SJ Higgins; Oxford
5. Gel Electrophoresis of Nucleic Acids, A practical Approach (1990) by D Rickwood and BD Hames. Oxford Univ. Press.
6. Genetics by Gardinar
7. Biotechnology by U.Satyanarayana

**VII. Co-Curricular Activities**

**a) Suggested Co-Curricular Activities**

1. Training of students by related advanced laboratory experts
2. Assignment (including technical assignments like identifying strategies in recombinant DNA technology)
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on tools and techniques in genetic engineering
5. Collection of material/figures/photos related concepts of genetic engineering for their better understanding of its applications
6. Visits to research organizations and laboratories.
7. Invited lectures and presentations on related topics by field/industrial experts.

## SEMESTER-IV

### COURSE 9: GENOMICS AND PROTEOMICS

Theory

Credits: 3

3 hrs/week

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#### I Learning Objectives:

1. To introduce students to the concepts of Genomics, Human genome project and databases
2. To enhance knowledge on gene structure and identification
3. to enable them learn advanced concepts of proteomics

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Imbibe concepts of Nucleotide sequence databases
2. Understand identification of gene and its functional sites
3. Illustrate concepts of gene expression, microarrays and concepts of Proteomics
4. Explain concepts of functional proteomics and phylogenetic analysis
5. Illustrate applications of Bioinformatics in various fields

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

1. **Genomics:** Nucleotide sequence Databases, its Analysis and Identification.
2. Goals of the Human Genome Project, cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism, nucleotides, DNA sequences.
3. **Sequence databases:** GeneBank, EMBL Nucleotide sequence databank, DNA Data Bank of Japan (DDBJ), database formats.

##### Unit 2:

1. Recombinant DNA technology, restriction enzymes, resource for restriction enzyme (REBASE), similarity search. Polymerase chain reaction, primer selection for PCR, BLASTn, application of BioEdit.
2. Genome information and special features, coding sequences (CDS), untranslated regions(UTR's), cDNA library, expressed sequence tags (EST).
3. Approach to gene identification; masking repetitive DNA, database search, codon-bias detection, detecting functional sites in the DNA.
4. Internet resources for gene identification, detection of functional sites, gene expression.

##### Unit 3:

##### Gene expression, DNA microarray and Proteomics:

1. **Gene expression:** Introduction, Basic steps for gene expression.
2. **Microarray:** Concept of microarrays; spotted arrays, oligonucleotide arrays, designing the experiment, Two-color microarray experiments.
3. **Proteomics:**-Protein sequence information, composition and properties, physico-chemical properties based on sequence, sequence comparison,
4. Primary databases, Secondary databases.
5. Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM250, BLOSUM62, local and global sequence alignment, multiple sequence alignment, useful programs, ClustalW, BLASTp.

**Unit 4:**

1. **Proteomics classification;** Tools and techniques in proteomics; 2-D gel electrophoresis, gelfiltration, PAGE, isoelectric focusing, affinity chromatography, HPLC, ICAT, fixing and spot visualization, Mass spectroscopy for protein analysis, MALDI-TOF, Electrospray ionization(ESI), Tandem mass spectroscopy (MS/MS) analysis; tryptic digestion and peptidefingerprinting (PMF).

2. Protein Micro array in protein expression, profiling and diagnostics, drug target discovery. Database searching, 3-dimensional structure determination by X-ray and NMR.

3. **Phylogenetic analysis:** Evolution, elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, comparison of genetic sequence of organisms, phylogenetic analysis tools-Phylip, Clustal W.

**Unit 5:****Applications of Bioinformatics in various fields:**

Environment, biotechnology, molecular biology, neurobiology, agriculture, drug designing,biomedical genome medicines, medical microbiology.

**SEMESTER-IV**  
**COURSE 9: GENOMICS AND PROTEOMICS**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Retrieve biological information from various databases
2. Retrieve literature from PUBMED and related databases
3. Perform Pair-wise and multiple sequence alignments and compare biological sequences
4. Analyze 3-dimensional protein structure
5. Perform phylogenetic analysis

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Introduction of National Center for Biotechnology Information (NCBI).
2. Introduction of biological search engine- Entrez
3. Introduction to literature database at NCBI and querying the PUBMED central database using the ENTREZ search engine
4. Analysis of 3D structure of protein using RasMol through command line.
5. Analysis of 3D structure of protein and nucleic acid using Cn3D.
6. Pair-wise sequence alignment by using ClustalW.
7. Multiple sequence alignment by using ClustalW.
8. Introduction of BioEdit. Effect of insertion INDEL from given amino acid using
9. Pairwise and Multiple sequence alignment using BioEdit.
10. Phylogenetic analysis using web tool.

**VI. References:**

1. Daniel, 2006, Biostatistics, Eighth Edition. John Wiley and sons.
2. Durbin, Eddy, Krogh, Mithison, Biological sequence analysis.
3. T.A. Attwood and D.J. Parry-smith, 2001, Introduction of Bioinformatics.
4. A.D. Baxevanis, 1998, Bioinformatics: A practical guide to the analysis of Genes and proteins, (Edited) B.F. Publication.
5. David W, 2005, Bio-informatics; sequence and Genome Analysis, 2<sup>nd</sup> Edition By Mount CBS publishers

**VII. Co-Curricular Activities**

**a) Suggested Co-Curricular Activities**

1. Training of students in accessing data bases and retrieve information
2. Assignments on data retrieval and structure prediction
3. Seminars, Group discussions, Quiz and projects on aspects of genomics and proteomics
4. Preparation of videos on tools and their usage
5. Visits to facilities and organizations working on advanced concepts of Genomics and proteomics
7. Invited lectures and presentations on related topics by field experts.

**SEMESTER-IV**  
**COURSE 10: PROGRAMMING IN C**

Theory

Credits: 3

3 hrs/week

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**I Learning Objectives:**

1. To know the Basic concepts of Programming.
2. To gain the knowledge of C- programming language.
3. To develop logics which will help them to create programs and applications in C using functions, pointers, file handling.

**II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Explain about C and their applications in bioinformatics analysis.
2. Understand the concepts of Arrays, Strings and Structures which helps them to solve the real time problems.
3. Describe the concepts of Unions
4. Explains about the concepts of File handling and its operations
5. Gain knowledge about pointers and their applications

**III. Syllabus: (Total Teaching Hours: 45)**

**Unit 1:**

**Introduction to C**

1. History of C
2. Characteristics of C
3. Program Structure, Constants.
4. Data types, Variables, Keywords, Console Input/output Statements, Compilation and Execution.

**Unit 2:**

**Operators, Branching & Looping Statements**

1. Arithmetic Unary Assignment Relational & Logical Conditional
2. If Statement, Nested if, Statement else-if.
3. Ladder switch, Statement Looping.
4. Concepts for loop while loop do-while loop Jump Statements.

**Unit 3:**

**Arrays**

1. Array Concepts Rules & Restrictions.
2. Single & Multi-Dimensional Arrays
3. Types of Functions, Functions and Arrays Function.
4. Prototyping, Scope of Variables Built-in Functions

**Unit 4:**

1. String Functions, String Manipulation.
2. Pointer Concepts, Pointers and Functions Pointers and Arrays. Array of Pointers, Static Initialization, Pointers and Structures, Illegal indirection.
3. Defining New Data types, Unions Type Casting Enumerated, Data types Static Variables, Type

Definition.

## **Unit 5:**

### **Pointers**

1. Null pointers, pointers and settings
2. Pointer and two – dimensional arrays
3. Function philosophy
4. Function basics, Function prototype



**SEMESTER-IV**  
**COURSE 10: PROGRAMMING IN C**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Understand how to write the programs by using C-language.
2. Expertise in solving the problems by application of C- programming.
3. Perform Multithreading
4. Write program for stacking
5. Work with Applet

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Find the prime numbers between 1 to 50
2. Write a program which uses switches and break case statements.
3. Find out length of given string
4. Write a program of insertion sort.
5. Write a program which implements stack operation.
6. Multithreading using get property.
7. Multithreading using sleep property.
8. Write a program which implements mouse listener and mouse motion listener.
9. Creating a frame window in an applet.
10. Draw line, rectangle, oval in an applet.

**VI. References:**

1. Let us C by Yashwant K., 4th Ed.
2. The C programming language by Ritchie, D.M., 2nd Ed.
3. C: The Complete Reference is written by Herbert Schildt.
4. Programming in ANSI C is written by E Balagurusamy.

**VII. Co-Curricular Activities**

**a) Suggested Co-Curricular Activities**

1. Training of students on C programming
2. Assignments on Topics related in course
3. Seminars, Group discussions, Quiz and projects on aspects C programming
4. Preparation of videos on tools and their usage
5. Invited lectures and presentations on related topics.

**SEMESTER-IV**  
**COURSE 11: CHEMOINFORMATICS**

Theory

Credits: 3

3 hrs/week

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**I Learning Objectives:**

1. To enhance knowledge on topics from alkanes to amines and their reactions
2. To introduce to the concepts of Chemoinformatics and Pharmacokinetics
3. To enable students learn concepts of combinatorial chemistry

**II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Describe the reactions of aliphatic groups and reactive groups
2. Narrate concepts of amines and explain evolution of cheminformatics
3. Learn about Pharmacokinetics of drug metabolism and testing involved
4. Explain about concepts of Combinatorial chemistry
5. Access databases relevant to cheminformatics

**III. Syllabus: (Total Teaching Hours: 45)**

**Unit 1:**

**Concepts of Alkanes, alkenes, alkynes and some reactive groups:**

1. Alkanes, Alkenes and alkynes, Alkyl halides: rearrangement reactions of alkyl carbocation, Grignard reactions, nucleophilic substitution reactions;
2. Alcohols: esterification, dehydration and oxidation, reaction with sodium, phosphorus halides, ZnCl<sub>2</sub>/conc.- HCl, conversion of alcohols into aldehydes and ketones;
3. Aldehydes and Ketones: oxidation, reduction reactions,
4. Carboxylic acids: formation of esters, acid chlorides and amides, ester hydrolysis.

**Unit 2:**

**Concept of amines and introduction to Cheminformatics**

1. Amines: basicity of substituted anilines and aliphatic amines, preparation from nitro compounds, reaction with nitrous acid, azo coupling reaction of diazonium salts of aromatic amines.
2. Introduction to cheminformatics, Evolution of cheminformatics, History of chemical information science, Use of cheminformatics, Prospectus of cheminformatics, History of medicinal chemistry.

**Unit 3:**

**Pharmacokinetics and testing aspects**

1. Prodrugs and soft drugs, Drug targets, Drug solubility, Natural resources of lead compounds, Pharmacokinetics & drug metabolism.
2. Biological testing and bioassays, Preclinical testing and clinical trial, Synthesis, Patenting and manufacture, Complexes and chelating agents, Molecular modeling using computer.

**Unit 4:**

**Combinatorial chemistry, libraries and Peptide display libraries**

1. Combinatorial chemistry technologies & libraries. Solution phase synthesis, High-throughput synthesis and screening.

2. Combinatorial libraries, Analytical methods, Biopanning.
3. Peptide display libraries: Design and construction, Chemical literature, Chemical information searches, Chemical information sources, Chemical name and formula searching, Analytical chemistry (Constitutional Chemistry), Chemical history, Biography, Directories, and industry sources.

### **Unit 5:**

#### **Databases for Chemoinformatics**

1. Chemical Database Design. Bio Catalysts Database, The MOS Database, The Failed Reaction Database, Protecting Groups Database, Solid-Phase Synthesis Database Database concepts, structured query language, Design of chemical database, data abstraction, bio Catalysts Database, Reaction database, Failed reaction Database, Sequence Database, Spectra Database,
2. Toxicology Database

**SEMESTER-IV**  
**COURSE 11: CHEMOINFORMATICS**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Learn model building of biomolecules
2. Get introduced to PDB format and analyze it
3. Analyse the levels of protein organization using Rasmol and web tool
4. Work on homology modeling
5. Calculate energy values of biomolecules.

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Model building of nucleic acid, protein and organic molecules using the ISIS draw.
2. Model building of nucleic acid, protein and organic molecules using the chemsketch
3. Introduction to PDB.
4. Downloading and analysis of the pdb file of the biomolecules.
5. Analysis of Secondary and tertiary structure of protein using visualizing software like Rasmol.
6. Analysis of quaternary structure of protein using visualizing software like Rasmol.
7. Analysis of the secondary structure of protein using web tool.
8. Three dimensional structure prediction by using the homology modeling technique using SPDBV.
9. Energy calculation of the biomolecules using molecular mechanics and quantum mechanics. (Argus lab).
10. Calculate PI/MW of protein.

**VI. References:**

1. Andrew R Leach and Valerie J. Gillet. (2007). Introduction to Chemoinformatics. Springer publications.
2. Frank Jensen. (1999). Introduction to Computational Chemistry. John Wiley & Sons Ltd.
3. Johann Gasteiger and Thomas Engel. (2003). Cheminformatics. WILEY-VCH Verlag GmbH & Co, KgaA, Weinheim.
4. Vyas SP and Khar RK. (2002). Targeted and Controlled Drug Discovery. 1st edn, CBS Publisher and distributors (New Delhi).
5. Thomas Langauer. (2002). Bioinformatics from Genome to Drug. WILEY-VCH Verlag GmbH & co, KgaA, Weinheim.
6. Andrew R. Leach (2001). Molecular Modeling – Principles and Applications. Second Edition, Prentice Hall, USA
7. Fenniri, H. (2000). Combinatorial Chemistry – A practical approach. Oxford University Press, UK.
8. Lednicer, D. (1998). Strategies for Organic Drug Discovery Synthesis and Design. Wiley International Publishers.
9. Gordon, E.M. and Kerwin, J.F. (1998). Combinatorial chemistry and molecular diversity in drug discovery. Wiley-Liss Publishers

**VII. Co-Curricular Activities**

**a) Suggested Co-Curricular Activities**

1. Training of students on concepts of chemoinformatics with available online tools
2. Assignment on analysis of proteins conformation using various tools and encourage online submissions
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on concepts of the syllabus
5. Visits to advanced laboratories or firms working on the aspects of chemoinformatics
7. Invited lectures and presentations on related topics by subject experts.

## SEMESTER-V

### COURSE 12: STRUCTURAL BIOINFORMATICS

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. To introduce students to structural bioinformatics and structural analysis
2. To enhance knowledge on structural prediction
3. To educate them on the topic Macro-molecular interaction

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Understand the structural basis for biological phenomena
2. Explain conformational analysis of proteins using computational methods
3. Describe features about forces that determine the conformational analysis of nucleic acids
4. Learn aspects of protein structure prediction
5. Examine the aspects of genome sequencing

#### **III. Syllabus: (Total Teaching Hours: 45)**

##### **Unit 1:**

##### **Introduction:**

Overview of structural bioinformatics – understanding structural basis for biological phenomena– challenges in structural bioinformatics – integration of structural data with other data.

##### **Protein structures**

Conformational Analysis of proteins – Forces that determine protein structure – polypeptide chain geometries – Ramachandran Map – potential energy calculations – observed values for rotation angles.

##### **Unit 2:**

##### **Structural analysis**

Conformational analysis of nucleic acids – general characteristics of nucleic acid structure – geometries, glycosidic bond – rotational isomers and ribose puckering - forces stabilizing ordered forms – base pairing– base stacking.

##### **Unit 3:**

##### **Structural Prediction**

Structure Prediction Methods – Homology Modeling – Fold Recognition Methods – ab initio methods – Rosetta – CASP – prediction of secondary structure – Chou-Fasman, Garnier, Osguthorpe-Robson (GOR) methods (qualitative aspects only) – transmembrane structure prediction – solvent accessibility calculations and prediction

##### **Unit 4:**

##### **Macro-molecular interactions**

Interactomes – macromolecular interactions – protein-protein interactions – protein-DNA interactions – protein-ligand interactions – interactions databases – BIND, ProNIT – Docking – principles and methods

##### **Unit 5:**

##### **Current contours**

Genome sequencing – Proteomics – Phylogeny – Gene expression – Protein-protein interaction network

## SEMESTER-V

### COURSE 12: STRUCTURAL BIOINFORMATICS

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Access free online repositories of structural data
2. Retrieve right PDB structures and visualize them using PyMOL
3. Identify structural and functional domains of proteins
4. Predict structure of transmembrane proteins
5. Understand about protein-protein interaction networks

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Access public repositories of structural data- Protein Data Bank (PDB) and Electron Microscopy Data Bank (EMDB)
2. Access repositories and retrieve information from Protein Data Bank in Europe (PDBe) and PDBe-KB
3. Finding the right structures - UniProt and PDB
4. Viewing the structure - PyMOL
5. Domain identification in proteins using HMMER, Inter Pro and CATH
6. Access MemBrain for trans membrane protein prediction
7. DNAProDB for DNA protein interactions
8. Access STRING for protein-protein interaction networks

#### VI. References:

1. C.R.Cantor & P.R.Schimmel, Biophysical Chemistry Part - I, W.H. Freeman & Co., San Francisco, 1980.
2. C. Branden and J. Tooze, Introduction to Protein Structure, Garland Publishing Inc., New York, 1999.
3. P.E. Bourne and H. Weissig (Eds.) Structural Bioinformatics, John-Wiley and Sons, 2003
4. Molecular Modeling and Simulation, Tamar Schlick, 2002
5. Structural Bioinformatics, 2nd Edition, Jenny Gu and Philip Bourne, 2009
6. Protein Structure Prediction: a practical; approach, M. Sternberg, 1996
7. Textbook of Structural Biology, Liljas et al, 2010
8. Molecular Biophysics, Michael Daune, 1999
9. Introduction to Proteins: Structure, Function, and Motion, Kessel et al, 2010
10. Understanding Bioinformatics, M. Zvelebil, J. Baum, 2007

#### VII. Co-Curricular Activities

##### a) Suggested Co-Curricular Activities

1. Training of students on aspects of course using free online tools
2. Assignments on protein structure prediction and importantly domain identification
3. Seminars, Group discussions, Quiz, online tests etc.
4. Preparation of videos on tools as assignments for better understanding of students as peer group teaching
5. Collection of material related to every topic and share in google classroom
6. Visits to research organizations or firms on the aspects of topic
7. Invite guest lectures and presentations on related topics of structural Bioinformatics.

## SEMESTER-V

### COURSE 13: PROGRAMMING IN PEARL

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. To acquaint with on basics in perl and more on usage of scalar, arrays and hashes.
2. To gain knowledge of regular expressions concepts in perl and its major role in bioinformatics.
3. To understand the significance of perl modules in the advance programming skills.

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Understand basic concepts of biodiversity and its distribution.
2. Gain the knowledge of patterns of the biodiversity.
3. Appreciate the Biodiversity present in the India.
4. Acquire the knowledge on terminology of Biodiversity.
5. understand the importance information technology to identify the biodiversity in global way.

#### **III. Syllabus:** (Total Teaching Hours: 45)

##### **Unit 1:**

##### **Introduction to Perl**

1. The Organization of DNA and Organization of Proteins ,
2. In Silico, Limits to Computation Getting started with perl:- A Low and Long Learning Curve.
3. Perl's Benefits, Installing Perl on Your Computer, How to Run Perl Programs, Text Editors and Finding Help.
4. The art of programming: Individual Approaches to programming, Edit-Run-Revise (and Save), An Environment of Programs, Programming Strategies.

##### **Unit 2:**

##### **Programming**

1. The Programming Process, sequences and strings: Representing Sequence Data,
2. Transcription: DNA to RNA, Using the Perl Documentation
3. A Program to Store a DNA Sequence, Concatenating DNA Fragment.
4. Calculating the Reverse Complement in Perl, Proteins, Files, and Arrays , Reading Proteins in Files.

##### **Unit 3:**

##### **Arrays, Motifs and Loops**

1. Arrays Scalar and List Context.
2. Motifs and Loops:-Flow Control , Code Layout, Finding Motifs, Counting Nucleotides, Exploding Strings into Arrays,
3. Operating on Strings Writing to Files.

##### **Unit 4:**

##### **Subroutines and Bugs**

1. Subroutines, Scoping and Subroutines
2. Command-Line Arguments and Arrays

3. Passing Data to Subroutines, Modules and Libraries of Subroutines,
4. Fixing Bugs In YourCode

## **Unit 5:**

### **Mutations and Randomization**

1. Random Number Generators, A Program Using Randomization,
2. .A Program to Simulate DNA Mutation, Generating Random DNA, Analyzing DNA.
3. The genetic code:-Hashes, Data Structures and Algorithms for Biology,
4. The Genetic Code, Translating DNA into Proteins, Reading DNA from Files in FASTA Format, Reading Frames



## SEMESTER-V

### COURSE 13: PROGRAMMING IN PEARL

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Understand and Expertise in programming in Perl.
2. Write the programs for Biological data with the application of Perl programming
3. Do MAP construction
4. Work with different software tools
5. Create databases

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Installing Perl on your PC.
2. Create Perl script.
3. Write a program to store protein sequence.
4. Write a program to store DNA sequence.
5. Write a program to store RNA sequence.
6. Use Perl to concatenation of DNA
7. Use Perl to concatenation of protein sequence.
8. Perl script for to simulate DNA mutation

#### VI. References:

1. Beginning Perl for Bioinformatics by James Tisdall, O-Reilly publication.
2. Perl: Complete Reference Perl by Martin C. Brown, McGrawHill publication.
3. Mastering Perl for Bioinformatics by James D. Tisdall, O-Reilly Publication.
4. Teach Yourself Perl 5 in 21 days by David Till, Sams publishing.
5. Mastering Algorithms with Perl by Jon Orwant, Jarkko Hietaniemi and John Macdonald, O-Reilly Publication

#### VII. Co-Curricular Activities

##### Suggested Co-Curricular Activities

1. Invited talks by subject experts of Perl
2. Give assignments on programming to store biological sequences
3. Quiz, Group Discussions etc.,
4. Making of videos and material creating and sharing
5. Guest lectures and field visits.

## SEMESTER-V

### COURSE 14: VISUAL BASIC AND NET BANKING

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. Introduce students to the concepts of Visual Basic and VB-Net controls
2. To enhance knowledge on in-depth concepts of Jagged array in Java and OOP
3. To expose students to Java runtime polymorphism for learning multilevel inheritance

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Learn concepts of Visual Basic.Net and understand the framework components
2. Imbibe the basic controls of VB.Net
3. Explain Jagged array and OOP using .Net
4. Work with Java Runtime and explain polymorphisms with multilevel inheritance
5. Understand ADO.Net components

#### **III. Syllabus:** (Total Teaching Hours: 45)

##### **Unit 1:**

##### **Introduction to Visual Basic (VB)**

1. Event driven programming, History of VB.Net, Features of VB.Net, Architecture of VB.Net[.Net server, frame work, services etc.].
2. Net Framework: framework components, classes, CLR, VB.Net IDE, VB.Net: Variables,Keywords, constants, Data types, Conditional statements, looping statements, case control statements.

##### **Unit 2:**

##### **VB-Net Basic controls**

Activex controls, Forms, Controls & properties Text Boxes, Labels, Command Button, Radio Button, Option Buttons, Check Boxes, List Box ,ComboBox,Scorroll Bar, Progress Bar, Group Box, Calendar, Date Time Picker, Picture Box, Image List, Rich Text Box, Popup/Content Menus, List View Control , Tree View Box.

##### **Unit 3:**

##### **Jagged array in Java**

1. The array class collections, lists, string class, jagged array, array list String class and function.

##### **Object Oriented Programming**

2. OOP using .net Classes Objects, constructor, destructor Methods, properties, delegates, assemblies, namespaces.

##### **Unit 4:**

##### **Java Runtime Polymorphism with multilevel inheritance**

1. Inheritance, Single, multiple, multilevel inheritance, Polymorphism-constructor overloading, method overloading, overriding, File operation-read, write, delete, Exception - type of errors, structured and unstructured exception.

2. Tracing errors: breakpoint, watch, quick watch, locals and autos.

### **Unit 5:**

#### **Understanding ADO.Net components**

Components of ADO.Net, Features of ADO.Net, Datasets, Data table, Datarow, datacolumn, Datareader, ADO.Net programming.

## SEMESTER-V

### COURSE 14: VISUAL BASIC AND NET BANKING

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Perform molecular docking using HEX
2. Do protein prediction and Model building using SPDB, Sybyl7.3 and SPARTAN
3. Run Molecular dynamic and modeling and simulation tools
4. Understand concept of energy minimization
5. Work on Homology modeling

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Molecular Docking of protein and ligand by HEX.
2. Protein Structure Prediction (Homology Modeling) using SPDBV.
3. Model Building and Energy minimization using Sybyl7.3.
4. Model Building and Energy minimization using SPARTAN.
5. Model Building and Energy minimization Gaussian.
6. Quantum chemical (QM) and molecular mechanics (MM) practical using SPARTAN.
7. Quantum chemical (QM) and molecular mechanics (MM) practical using Gaussian.
8. Molecular dynamics (MD) simulation using Gromacs.
9. Molecular dynamics (MD) simulation using Sybyl.
10. Molecular dynamics (MD) simulation using AMBER.

#### VI. References:

1. Bayross I. (2002). Programming in Visual Basic 6.0. BPB Publication, New Delhi.
2. Harriger R. Alka (1999). Introduction to Computer Programming with Visual Basic 6, Prentice Hall Publications, New Jersey
3. Visual basic.NET Black Book by Steven Holzner. ISBN: 1932111042
4. Learning Visual Basic.NET: by Jesse Liberty. O'Reilly publishers

#### VII. Co-Curricular Activities

##### a) Suggested Co-Curricular Activities

1. Training of students using online tools
2. Assignments related to course and online submission using real time data
3. Seminars, Group discussions and online quizzes
4. Preparation of videos on modeling and simulation tools usage
5. Collection of material for sharing on better understanding of concepts and encourage peer group teaching
6. Visits to.... Facilities, firms , research organizations etc
7. Invited lectures and presentations by experts of the field

## SEMESTER-V

### COURSE 15: BIODIVERSITY AND BIODIVERSITY INFORMATICS

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. To acquaint with Biodiversity.
2. To understand the application of information technology to explain the biodiversity
- 3.

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Understand basic concepts of biodiversity and its distribution.
2. Gain the knowledge of patterns of the biodiversity.
3. Appreciate the Biodiversity present in the India.
4. Acquire the knowledge on terminology of Biodiversity.
5. understand the importance information technology to identify the biodiversity in global way.

#### **III. Syllabus:** (Total Teaching Hours: 45)

##### **Unit 1:**

##### **Introduction to Biodiversity**

1. Definitions, Basic Concept Of Biodiversity, Distribution - Latitudinal Gradients, Hotspot.
2. Identification of plants and animals: Floral and faunal survey techniques, .
3. Evolution and History - Evolutionary Diversification,
4. Biodiversity and Ecosystem Services - The Balance Of Evidence.

##### **Unit 2:**

##### **Patterns in Biodiversity**

1. Global Patterns Of Biodiversity – Measuring Biodiversity, Cataloging and Discovering Species, Geographical Patterns Of Species Richness
2. Biogeography, Importance Of Distribution Patterns(Local Endemics, Sparsely Distributed Species, Migratory Species),
3. Elements of Biodiversity - Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Patterns Of Species Diversity

##### **Unit 3:**

##### **Biodiversity Informatics**

1. Composition and distribution of biodiversity in India.
2. Taxonomic Database Working Group (TDWG) standards,
3. compatibility and interpretability,taxonomically intelligent systems.
4. Software used to discover phylogenies, use and status of specimen data, species distribution,
5. software projects for compiling data

##### **Unit 4:**

##### **Biodiversity Maps and Biodiversity databases**

1. Biodiversity maps- Definition, application.
2. Sources of Biodiversity Maps.
3. Tools used biodiversity maps preparation.
4. Biodiversity databases- Types and significance

## **Unit 5:**

### **Ethics Of Conservation**

1. Practice of Biodiversity Ethics of Conservation – Values of Biodiversity, Biopiracy, Hybridized plants,
2. GM crops (benefits & criticism), Economic Value of Biodiversity & Legal issues related to uses of biodiversity,
3. Ethical issues related to uses of biodiversity and Conservation issues related to uses of biodiversity, Global Conservation Issues.
4. *Ex-situ* conservation: Protected Area Network of India, Assessing the status of species, Threats from invasive alien species.

## SEMESTER-V

### COURSE 15: BIODIVERSITY AND BIODIVERSITY INFORMATICS

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

- 1 Explore Biodiversity databases
2. Expertise in identifying the hot spots, endangered species by applying the Information Technology
3. MAP biodiversity
4. Get trained in various software tools
5. Create database structures

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Working on different types of Biodiversity databases and retrieval of the data.
2. Study of data bases structure and creating database.
3. Demonstration of study of different species identification systems.
4. Construction of MAP of biodiversity.
5. Hands on training on different software tools used to prepare the biodiversity databases

#### VI. References:

- 1) Bioinformatics sequence and genome analysis – by David W. Mount.
- 2) Practical taxonomic computing – by Pankhurst R.J

#### VII. Co-Curricular Activities

##### Suggested Co-Curricular Activities

1. Invited talks by subject experts of environmentalists.
2. Visit to biodiversity park.
3. Quiz, Group Discussions etc.,
4. Making of videos and animations on biodiversity in india

## SEMESTER-VII

### COURSE 16 A: ADVANCED MOLECULAR BIOLOGY

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. To acquire in-depth knowledge in Molecular Biology, cellular, genetic, and molecular mechanisms in living organisms
2. To learn the process of replication, enzymes involved in replication and DNA repair
3. To get hold of basic knowledge related to processes of transcription and translation in prokaryotes and eukaryotes

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Understand the recent development and techniques in the field of molecular biology
2. Narrate mechanisms of replication, transcription and translation in prokaryotes and eukaryotes
3. Gain the knowledge on role of inhibitors in the mechanisms of replication, transcription and translation.
4. Focus on design of drugs for prevention of diseases at the level of transcription and translation
5. Understanding various DNA repair mechanisms will provide insight into development of novel therapies for various disorders

#### **III. Syllabus:** (Total Teaching Hours: 45)

##### **Unit 1:**

##### **DNA Replication in Prokaryotes:**

1. Origin and Direction of replication, Semi-discontinuous replication, DNA polymerases of prokaryotes and their mechanism of action; Helicase, Primase, Ligase, Single strand binding proteins and DNA Topoisomerases and their types.
2. Replication strategies for replicating circular DNA: Rolling circle mode of replication and D-loop mode of replication. Inhibitors of replication.

##### **DNA Replication in Eukaryotes:**

Eukaryotic DNA Polymerases, Reverse transcriptase, Strategies for replicating linear DNA, Fidelity and Processivity of replication, Inhibitors of replication, Replication of linear chromosomes, telomeres, telomerase

##### **Unit 2:**

**Transcription in Prokaryotes:** Prokaryotic RNA polymerases, Conserved sequences of Prokaryotic promoters, mechanism of transcription, riboswitches, Inhibitors of transcription

**Transcription in Eukaryotes:** Types of eukaryotic RNA polymerases, Types of eukaryotic promoters, Enhancers, Transcriptional factors, mechanism of transcription, Inhibitors of transcription

##### **Unit 3:**

**Post Transcriptional Modifications:** Modifications of pre-mRNA - capping, and polyadenylation, types of Introns and splicing mechanisms, Alternative splicing and its importance, modifications of pre-rRNA and modifications of pre-tRNA, RNA editing and significance



**Unit 4:**

**Protein synthesis:** Initiation, elongation and termination of translation in Prokaryotes, Initiation, elongation and termination of translation in Eukaryotes, Inhibitors of protein synthesis, Post translational modifications of proteins, Protein targeting and processing, Molecular chaperons

**Unit 5:**

**DNA Repair mechanisms:** Photo reactivation, Excision repair mechanism, Post replication repair mechanisms- Recombination repair, Mismatch repair system, SOS response, and role of RecA and Lex A, Transcription-repair coupling

## SEMESTER-VII

### COURSE 16 A: ADVANCED MOLECULAR BIOLOGY

Practical

Credits: 1

2 hrs/week

#### Practical Syllabus: Course 16: Advanced Molecular Biology

#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Isolate DNA from various sources and determine its purity
2. Determine melting temperature of DNA
3. Analyse the sugar to phosphate ratio for nucleic acids
4. Perform restriction digestion of nucleic acid and check the end products
5. Run agarose gel electrophoresis and observe separated bands

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Isolation of DNA from different sources.
2. Determination of melting temperature ( $T_m$ ) of DNA
3. Estimation of DNA by UV absorption method and determination of purity.
4. Determination of sugar and phosphate ratios in DNA.
5. Agarose gel electrophoresis of Nucleic acids
6. Restriction digestion of lambda DNA and perform agarose gel electrophoresis

#### VI. References:

1. Molecular Biology of the Gene - J. D. Watson et al., 7<sup>th</sup> ed
2. Molecular Biology of the Cell – H. Lodish, Arnold Berk et al., 7<sup>th</sup> ed
3. Molecular Biology of the Cell – Bruce Alberts, Alexander D. Johnson et al.,
4. Molecular biology: a comprehensive introduction to prokaryotes and eukaryotes – D. Freifelder, 2<sup>nd</sup> ed
5. Fundamental Molecular Biology – Lizabeth A. Allison
6. Leininger's Principles of Biochemistry- Nelson and Cox, Worth Publish., Inc. New York
7. Biochemistry - L. Stryer., 4<sup>th</sup> ed, W.H. Freeman Press, San Francisco, USA
8. Principles of Genetics - E.J. Gardner and D.P. Snustad. John Wiley & Sons, New York

#### VII. Co-Curricular Activities

##### a) Suggested Co-Curricular Activities

1. Training of students in the theory and practical aspects of Molecular biology
2. Assignment related to replication, transcription and translation aspects and control using models
3. Seminars, Group discussions, Quiz, Debates and peer group teaching.
4. Preparation of videos on concepts of the topics covered
5. Collection of material/figures/photos related to the topics.
6. Visits to firms, research labs etc and expose students to techniques
7. Invited lectures and presentations on related topics by experts.

## SEMESTER-VII

### COURSE 16 B: ADVANCES IN STRUCTURAL INFORMATICS

Theory

Credits: 3

3 hrs/week

#### I Learning Objectives:

1. To learn concepts of nucleic acid conformation and protein structural organization & folding
2. Understand the concept of Structure prediction, molecular modelling and energy minimization
3. Learn about bond stretching and bond bending in molecular mechanics
4. Understand molecular dynamics using MD methodology

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand protein – protein interactions and nucleic acid conformations
2. Verify protein folding using various tools
3. Implement the knowledge of potential energy functions and energy minimization in molecular modelling
4. Explain concepts of molecular mechanics
5. Work on algorithms for studying molecular dynamics.

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

##### Structural biology and structural databases :

1. Outlines of RNA folding, RNA loops.
2. Conformational study- ribose ring conformations, ribose-ring puckering. protein-protein interactions, protein ligand interactions.
3. 3-dimensional structures of membrane proteins, importance of  $\alpha$  helix and loops.
4. Structural databases: Molecular modelling Data Bank (MMDB). Secondary structure, three-dimensional structure prediction, protein folding and functional sites, protein folding classes

##### Unit 2:

##### Protein structure prediction:

1. Homology modelling, prediction of protein structure from sequences, functional sites.
2. Protein folding problem, protein folding classes.
3. Protein identification and characterization:- AACompIdent, TagIdent, PepIdent and MultiIdent, PROSEARCH, PepSea, PepMAPPER, FindPept,
4. Predicting transmembrane helices, Primary structure analysis and prediction, Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search.

##### Unit 3:

##### Molecular Modelling and Molecular Mechanics:

##### Molecular modelling:

1. Introduction, force field, quantum chemistry, Schrödinger equation, potential energy functions. energy minimization, local and global minima, saddle point, grid search.

2. **Various approximations;** LCAO, HF, semi-empirical calculations; single point calculations, full-geometry optimization methods, ZDO, MNDO, CNDO, NDDO, AM1, PM3, RM1. conformational search, Z-matrix, docking, molecular modelling packages.

#### **Unit 4:**

##### **Molecular mechanics:**

1. Definition, balls and springs, force fields, bond-stretching, bond-bending, dihedral motions, out of plane angle potential, non-bonded interaction, coulomb interactions, conformational search, united atoms and cut-offs.

2. Derivative methods: First-order methods; Steepest descent, conjugate gradient, Second order methods; Newton-Raphson method.

#### **Unit 5:**

##### **Molecular dynamics:**

1. Introduction, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, algorithm for time dependence; leapfrog algorithm,

2. Verlet algorithm, Boltzman velocity, time steps, duration of the MD run. Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions

## SEMESTER-VII

### COURSE 16 B: ADVANCES IN STRUCTURAL INFORMATICS

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Retrieve sequences from database
2. Study the primary and secondary structure of proteins from databases
3. Develop 3D model using Moddler
4. Work on approaches to minimize energy points
5. Simulate protein- ligand complexes

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Understanding PubMed database.
2. Analysis of protein sequence from protein database.
3. Analysis of gene sequence from nucleotide database.
4. Getting and analysis of primary protein structure.
5. Secondary structure analysis of protein.
6. Tertiary protein structure analysis using Rasmol
7. Protein 3D model building using Moddler
8. Energy minimization of protein molecule
9. Determination of Maxima and Minima energy points
10. Different approaches for binding site identifications
11. Protein – ligand complex MD simulation

#### VI. References:

1. Structural bioinformatics, Volume 44, 2003. Philip E Bourne, Helge Weissig. Wiley Online Library.
2. Protein Bioinformatics: An Algorithmic Approach to Sequence and Structure Analysis by Ingvor Eidhammer, Inge Jonassen, William R. Taylor. 2002. Wiley Publishers.

#### VII. Co-Curricular Activities

##### a) Suggested Co-Curricular Activities

1. Training of students on areas of structural informatics
2. Assignments on protein structure prediction and molecular modeling
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on tools and techniques used in structural bioinformatics
5. Collection of material/figures/photos related to subject topics
6. Visits to firms and research organizations etc working in these areas
7. Invited lectures and presentations on related topics by field/industrial experts.

## SEMESTER-VII

### COURSE 17 A: MOLECULAR GENETICS

Theory

Credits: 3

3 hrs/week

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#### I Learning Objectives:

1. To learn about the Mendelian genetics and its extensions
2. To learn about chromosome, its organisation and linkage maps
3. To gain knowledge about mapping of bacterial genes, mutations and genetic disorder in us

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand the Mendelian genetics and changing concept of gene
2. Acquire knowledge about chromosome and its organisation
3. Understand about linkage maps
4. Understand bacterial genetics and mapping of the genes
5. Comprehensive and detailed understanding of the normal and mutant genes

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

**1. Basic principles of Mendelian Genetics:** Dominance, segregation, independent assortment; Extensions of Mendelian principles- Codominance, Incomplete dominance, Penetrance and Expressivity, Gene Interactions- Types of Epistasis - modification of Mendelian ratios.

**2. Multiple alleles** - ABO blood groups in humans, Rh blood group incompatibility, Coat color in Rabbits, Sex determination, Sex linked inheritance, Extra chromosomal inheritance - Inheritance of mitochondrial and chloroplast genes, Maternal inheritance.

##### Unit 2:

**1. Linkage and mapping:** Discovery of linkage, Morgan's experiments, Cytological proof of crossing over, 2-point test cross, 3-point test cross, Recombination, Interference, Tetrad analysis and gene mapping in Neurospora.

**2. Mutations:** Types of mutations - Mutagens and their mechanism of action, Molecular mechanism of mutations; Structural and Numerical alteration of chromosomes – Deletion, Duplication, Inversion, Translocation, Ploidy and their genetic implications.

##### Unit 3:

**Bacterial Genetics:** Conjugation – Discovery, Mapping bacterial genes by conjugation. Transformation - Discovery, Mapping bacterial genes by Transformation. Transduction - Discovery, Mapping bacterial genes by Transduction. Fine structure of rII locus: Complementation analysis, Deletion mapping.

##### Unit 4:

**1. Chromosome organization-** Nucleosome, loops and scaffolds, Nucleosome phasing, chromatin remodelling and dynamics- Euchromatin and Heterochromatin.

**2. Modern concept of the gene** - Split genes, Overlapping genes, Repeated genes– interspersed and tandem repeats, Satellite DNA - mini satellites and microsatellites, Nested genes. Gene families (Clustered and Dispersive– Haemoglobin gene and Histone gene clusters)

##### Unit 5:

**Genetics of monogenic diseases** – Phenylketonuria, Cystic fibrosis, Sickle cell anaemia

**Genetics of complex diseases**–Cancer, Diabetes, Alzheimer's disease, Genotype–Phenotype relationships

## SEMESTER-VII

### COURSE 17 A: MOLECULAR GENETICS

Practical

Credits: 1

2 hrs/week

#### Practical Syllabus: Course 17: Molecular Genetics

#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Perform Karyotyping
2. Illustrate ploidy of cells- onion root tips
3. Narrate about gene interactions
4. Solve problems related to gene linkage and mapping
5. Explain gene interaction by Mendelian inheritance

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Karyotyping of normal & abnormal chromosome sets
2. Study of polyploidy in onion root tips
3. Problems on monohybrid ratio, dihybrid ratio,
4. Problems on gene interactions
5. Problems on linkage and mapping- 2 point test cross,3-point test cross

#### VI. References:

1. Fundamentals of Biochemistry: Life at the Molecular Level (2016) by Voet, Voet and Pratt. Fifth edition, John Wiley & Sons, N.Y.
2. Molecular Biology of the Gene (2017) by Watson, Hopkin, Roberts, Stertz, Weiner, Freeman Pub., San Francisco.
3. Lewin's Genes XII (2017) by Krebs, Goldstein, Kilpatric. Oxford University Press, London.
4. General Genetics by S. Owen and Edger.
5. Fundamentals of Genetics by Gardner and Snustad.
6. Principles of Genetics (2006) by Gardner, Simmons and Snustad. Eighth edition, John Wiley & Sons, New York, USA.
7. An Introduction to Genetic Analysis - Griffiths, Wessler, Lewontin, et al., 11<sup>th</sup> ed  
Genetics - M. W. Strickberger, 3<sup>rd</sup> ed
8. Principles of Genetics - E. J. Gardner, M. J. Simmons, D. P. Snustad, 8<sup>th</sup> ed
9. Genetics: A Conceptual approach. - Benjamin A. Pierce 5<sup>th</sup> ed

#### VII. Co-Curricular Activities

##### a) Suggested Co-Curricular Activities

1. Training of students by related subject experts
2. Assignment and problems on Genetics and inheritance
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on subject topics/
5. Collection of material/figures/photos related to topics of paper
6. Invited lectures and presentations on related topics by field/industrial experts.

**SEMESTER-VII**  
**COURSE 17 B: SYSTEMS BIOLOGY**

Theory

Credits: 3

3 hrs/week

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**I Learning Objectives:**

1. To enable students to understand the basic concepts of systems biology.
2. To explain and discuss systems approach to solve biological problems
3. To understand the concepts of networks and graphs and construct and analyse biological networks

**II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Learn about biological networks and their types
2. Simulate and optimize metabolic networks
3. Illustrate signalling networks and learn their controls and modulation
4. Explore Databases of systems biology
5. Apply concepts of synthetic biology for microbial engineering

**III. Syllabus: (Total Teaching Hours: 45)**

**Unit 1:**

**Introduction & Biological Networks:**

1. Systems Biology: Emergent property, Applications in health and diseases. Microarrays and its applications in systems biology. Self-organizing maps and Connectivity maps-definition and its uses.
2. Biological Networks: Degree distribution, Clustering coefficient, Random networks, Scale-free networks, small-world effect.

**Unit 2:**

**Simulation of pathways:**

1. Metabolic network, Metabolic reconstruction, Flux Balance Analysis (FBA): Translating biochemical networks into linear algebra, Stoichiometric matrix, Elementary mode, Extreme pathways, Objective function, Optimization using linear programming.
2. Genomescale cellular models: Virtual Erythrocytes, Global human metabolic model

**Unit 3:**

**Signalling & Experimental methods in systems biology:**

1. Slow and auto-regulation The coherent FFL and incoherent FFL, single-input module (SIM): LIFO and FIFO, DOR, signaling networks and neuronal circuits.
2. Robustness and optimality in Biological complex systems – Biological Robustness: System control, modularity, decoupling.
3. Optimal design of gene circuits I- cost and benefit: gene circuits II selection of regulation.
4. Stochasticity in gene expression.

**Unit 4:**

**Databases and software for Systems Biology:**

1. Introduction- databases: KEGG, EMP, MetaCyc.



2. Expression databases and other databases related to systems biology.
3. Cytoscape, visANT& Cell Designer.

**Unit 5:**

**Synthetic Biology:**

1. Introduction, definition and Basics, Synthetic Oligonucleotide/DNA-based, RNA-based, Peptide-based Technologies and Applications.
2. Technologies and Applications of Directed Evolution and Microbial Engineering, Potential Hazards of Synthetic Biology, iGEM.

**SEMESTER-VII**  
**COURSE 17 B: SYSTEMS BIOLOGY**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Construct self-organizing maps
2. Determine clustering coefficients for biological networks
3. Analyze flux balance
4. Explore databases of KEGG and MetaCys.
5. Explore biological and metabolic pathways

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Self-organizing maps constructions
2. Biological networks and clustering coefficient determination
3. Working with published mathematical models pertaining to some biological systems
4. Flux Balance Analysis
5. Exploring KEGG, EMP and MetaCyc database for biological pathways, metabolism, cellular process, genetic information processing.
6. Exploring Cytoscape, visANT& Cell Designer

**VI. References:**

1. Introduction to Systems Biology, S. Choi, Humana Press, 2007.
2. Linked – The New Science of Networks, Albert-László Barabási, Perseus Publishing, 2002.
3. Networks – an Introduction, Mark Newman, Oxford University Press, 2010.
4. Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, Chapman & Hall/CRC, 2007.
5. Synthetic Biology: A Primer by P.S. Freemont & R.I. Kitney, Imperial College Press, 2012.

**VII. Co-Curricular Activities**

**a) Suggested Co-Curricular Activities**

1. Training of students in related subject topics
2. Assignments on simulation of biological pathways
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on tools and procedures used for the subject topics
5. Collection of material/figures/photos related to topics
6. Visits to Facilities, firms, research organizations etc to learn the practicals
7. Invited lectures and presentations on related topics by field/industrial experts.

## SEMESTER-VII

### COURSE 18 A: BIostatISTICS AND APPLICATIONS

Theory

Credits: 3

3 hrs/week

#### I Learning Objectives:

1. To learn the importance of mean, standard error, standard deviation and their significance in presenting the data.
2. To develop basic concepts of probability theory and distributions
3. To gain knowledge about statistical tests of significance for making statistical inferences

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

- . Learn basic concepts of Biostatistics and interpret results of descriptive statistical methods effectively; communicate the results of statistical analyses accurately and effectively.
- Acquaint the knowledge about the laws of probability and probability distribution.

Learn the basic concepts of correlation and regression and statistical tests of significance and

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

**Introduction to Descriptive Statistics:** Introduction-Statistical Terms – Data collection, classification and Representation-Measures of Central Tendency – Mean, Median, Mode, Geometric and Harmonic Mean – Measures of Dispersion – Range, Inter-Quartile Range – Stem & Leaf Diagram – Boxplot – Mean. Deviation Variance and Standard deviation, Coefficient of Variation and Standard error.

##### Unit 2:

**Inferential Statistics and Probability Distribution:** Events and Probability – Conditional probability – Baye’s Theorem – Probability distribution – Binomial Distribution, Poisson Distribution – Normal distribution and Application problems

##### Unit 3:

**Analysis of Variance& Hypothesis Testing- I:** ANOVA – Variation – Assumption – Test – One-way analysis of variance – sources of variation – Multiple comparisons procedures and applications.

##### Unit 4:

**Analysis of Variance& Hypothesis Testing- II:** One and Two sided confidence intervals – types of error – Student’s t test – F- test – Chisquare test – paired samples – Independent samples – equal variances – unequal variances

##### Unit 5:

**Correlation and Regression& Current Contours:** Introduction – Correlation –Types – Measures – Scatter plot – Spearman’s rank correlation coefficient – Karl Pearson’s correlation coefficient – Regression Analysis – Types – Method of Least Square – Regression coefficient – Difference between Regression and Correlation, Single DNA sequence analysis: - Signal modelling- Pattern analysis- Multiple DNA/protein sequence analysis.

## SEMESTER-VII

### COURSE 18 A: BIostatISTICS AND APPLICATIONS

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. To offer hands on experience in performing data analysis by using mean, median and mode
2. To provide skills in data analysis by Analysis of variance
3. To provide knowledge to calculate correlation and regression coefficient
4. To work with simple random sampling
5. Do graphical representation of data

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Graphical representation of Data (Bar diagram, pie diagram and frequency curve).
2. Measuring central tendencies- Median, Mode, Geometric Mean and Harmonic Mean for grouped and ungrouped data
3. Analysis of Variance (One way and Two way classification)
4. Calculation of Correlation and regression coefficient along with their test of significance
5. Procedures of selecting a simple random sample

#### VI. References:

1. N. Gurumani, An Introduction to Biostatistics, 2nd Revised Edition, MJP Publishers, Chennai, 2000.
2. B.K. Mahajan, Methods in Biostatistics for Medical Students and Research Workers, Jaypee Publishers, 6th Edition, 1997.
3. Sundar Rao, An Introduction to Biostatistics, Prentice- Hall of India, 3rd Edition, 2004.
4. P. Mariyappan, Biostatistics: An Introduction, Pearson, Chennai, 2013.

#### VII. Co-Curricular Activities

##### a) Suggested Co-Curricular Activities

1. Training of students by related subject experts
2. Assignments on topics of ANOVA and sample collection and analysis
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos some topics for peer group teaching
5. Collection of material to be shared in the class
6. Invited lectures and presentations on related topics by field experts.

**SEMESTER-VII**  
**COURSE 18 B: BIOINFORMATICS ALGORITHMS**

Theory

Credits: 3

3 hrs/week

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**I Learning Objectives:**

1. To provide basic knowledge on algorithms
2. To enable them learn aspects of Dynamic programming algorithms and also provide the details about graph-based algorithms.
3. To enhance knowledge on the aspects of genetic algorithms for DNA sequencing.

**II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Apply knowledge of algorithms in computing
2. Performing sorting, searching and do string matching
3. Work with graphs using tools
4. Design algorithms and analyse data

**III. Syllabus: (Total Teaching Hours: 45)**

**Unit 1:**

**Computing Algorithms**

1. Algorithms in Computing, Analyzing algorithms, Designing algorithms
2. Asymptotic notation, Standard notations, Big 'O' notations
3. Time and space complexity of algorithms and common functions

**Unit 2:**

**Sorting, Searching & Strings Matching**

1. **Sorting:** Bubble sort, Insertion sort, Selection sort, Merge Sort, Quick Sort, External sort: K-way merge sort, balanced merge sort
2. **Searching:** Binary Search, Fibonacci Search. String
3. **Matching:** Naïve algorithm, Boyer Moore algorithm.

**Unit 3:**

**Graphs**

1. Representation of Graphs, Breadth First Search, Depth First Search,
2. Topological Sort, Connected Components, Minimum Spanning Tree
3. Single-Source Shortest Path: Dijkstra's Algorithm, All-Pairs Shortest Paths, Coloring of Graphs.

**Unit 4:**

**Trees**

Forests, DAGs, Ancestors, and Descendants, Binary Search Trees, Querying a Binary search tree, Insertion and Deletion, Tree Traversals, AVL-Trees, Rotations, Insertion, Deletion, B-trees

**Unit 5:**

**Algorithm Design and Analysis**

1. The substitution method, The iteration method, Divide and Conquer, Greedy Algorithms.
2. Dynamic Programming: Traveling Sales Person Problem Backtracking Algorithms: 8-queens Problem.

**SEMESTER-VII**  
**COURSE 18 B: BIOINFORMATICS ALGORITHMS**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Work with various algorithms
2. Learn Kruskal algorithm for creating minimum spanning tree
3. Perform pattern search
4. Work with Tree visualising tools
5. Work with various algorithm design techniques

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Algorithm design techniques
2. Sequence search algorithms
3. Creating Minimum spanning Tree using Kruskal Algorithm
4. Pattern searching using Boyer Moore Algorithm
5. Dijkstra's algorithm for finding shorted path
6. TREE Search Algorithms
7. AVL Tree visualization
8. Solve TSP algorithm
9. Tree Traverse Algorithm

**VI. References:**

1. Data Structures by Seymour Lipschutz., Tata Mc-Graw-Hill publication. 2007
2. Introduction to Algorithms (3rd Ed.) by T .H. Cormen, C. E. Leiserson, R .L. Rivest., The MIT Press. 20071.
3. Fundamentals of Algorithms by E. Horowitz and S. Sahani., Galgotia Book source Pvt. Ltd. 1999
4. Fundamentals of Algorithms by E. Horowitz and S. Sahani., Galgotia Book source Pvt. Ltd. 1999

**VII. Co-Curricular Activities**

**a) Suggested Co-Curricular Activities**

1. Training of students by related field experts
2. Assignments on topics related to any of the 5 units of the subject
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on tools and algorithms
5. Collection of material and flowcharts for peer group teaching
6. Visits to Facilities, firms , research organizations etc of relevant field
7. Invited lectures and presentations on related topics by field/industrial experts.

## SEMESTER-VII

### COURSE 19 A: BIOLOGICAL MODELING

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. To impart knowledge on physiological modelling of various systems
2. To enable them learn neuron modelling to modelling of immune system
3. To enhance knowledge on control system of human physiology

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Categorize different types of biological models and design a quantitative model for eye movement system.
2. Develop a model of a neuron using Hodgkin Huxley exp setup.
3. Differentiate a spindle receptor and Golgi tendon bodies.
4. Understand a basic model of a thermoregulatory system.
5. Understand the behavior of immune system

#### **III. Syllabus:** (Total Teaching Hours: 45)

##### **Unit 1:**

##### **Physiological modelling, Eye movement model:**

1. Steps in modelling, purpose of modelling, lumped parameter models, distributed parameter models, compartmental modelling, modelling of circulatory system.
2. Eye movement model:
3. Four eye movements, quantitative eye movement models, validity criteria.

##### **Unit 2:**

**Model of neurons :** Biophysics tools, Nernst Equation, Donnan Equilibrium, active transport (Pump) GHK equation, action potential, voltage clamp, channel characteristics, Hodgkin Huxley conductance equations, simulation of action potential, electrical equivalent model of a biological membrane, impulse propagation-core conductor model, cable equations.

##### **Unit 3:**

**Neuromuscular system:** Modelling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex, reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome.

##### **Unit 4:**

**Modelling the immune response:** Behaviour of the immune system, linearized model of the immune response. Modelling of insulin glucose feedback system and Pulsatile insulin secretion.

##### **Unit 5:**

**Thermo-regulatory systems:** Thermoregulatory mechanisms, electrical model of thermoregulatory system, controller model, validation and application.

## SEMESTER-VII

### COURSE 19 A: BIOLOGICAL MODELING

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Work with MATLAB and design biological models
2. Learn Simulation of various biological systems
3. Develop models using specialized tools
4. Illustrate simulation of sensory organs using MATLAB
5. Simulate complex systems of human physiology

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Simulations thermometer system using MATLAB
2. Simulation of Nernst/Goldman Equation using MATLAB
3. Simulation of eye movement using MATLAB
4. Simulation using HHSim
5. Simulation using Neurons in Action
6. Developing a model of a neuron using NEURON
7. Electrical simulation of thermoregulatory model

#### VI. References:

1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.TeriBahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey
4. Biomedical Engineering Handbook by Bronzino (CRC Press)
5. Biological Modelling and Simulation- A Survey of Practical Models, Algorithms and Numeric methods. Russell Schwartz. 2008. The MIT Press, Cambridge, Massachusetts, London..

#### VII. Co-Curricular Activities

##### a) Suggested Co-Curricular Activities

1. Training of students on modeling and simulation of human physiology
2. Assignments related to the application aspects and real time monitoring by students.
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on Biological modeling and applications
5. Collection of material and videos for sharing in google classroom
6. Visits to firms, research organizations working on these areas
7. Invited lectures and presentations on related topics by field/industrial experts.



## SEMESTER-VII

### COURSE 19 B: MATHEMATICAL APPROACHES IN BIOLOGY

Theory

Credits: 3

3 hrs/week

#### **I Learning Objectives:**

1. To understand the Mathematics and their application in biological systems.
2. To learn the basics of MAT LAB and its application to analyze the biological data
3. To gain the knowledge of Numerical analysis, Linear and Nonlinear differential equations to develop mathematical models to understand the biological systems.

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Get introduced to concepts of mathematics
2. Explain MATLAB fundamentals and data files
3. Explain numerical analysis and differentiation
4. Work with linear differential equations and systems
5. Illustrate Non-linear systems

#### **III. Syllabus:** (Total Teaching Hours: 45)

##### **Unit 1:**

##### **Introductory concepts of Mathematics:**

1. Basic mathematical concepts of Co-ordinate geometry, equations of line, circle and sphere; Trigonometric functions, graphs of functions
2. Types of functions: linear functions, Inverse Functions
3. Exponentials and logs, Vectors & Matrices: Scalars & Vectors, addition, subtraction, dot, cross & scalar triple products
4. Matrices: types, addition, subtraction, multiplication, transpose & inverse (general idea only) determinants, solutions of simultaneous equations using matrices

##### **Unit 2:**

##### **Basics of MATLAB:**

1. Introduction to MAT LAB, Analyzing vectors and matrices, Visualizing vector and matrix data.
2. Working with data files. Working with data type
3. Numerical algorithms of solving ODE.

##### **Unit 3:**

##### **Numerical Techniques:**

1. Numerical Analysis: Difference operators, errors and approximations, Interpolation
2. Numerical Differentiation, Numerical Integration by using Trapezoidal, Simpson's 1/3 and 3/8 rule, 3. Weddle, Gauss-Legendre, Monte Carlo methods of integration.

##### **Unit 4:**

##### **Linear Difference Equations & Systems**

Techniques for one-dimensional ordinary differential equation separation of variables, fixed points, stability, phase line, applications to population growth.

## **Unit 5:**

### **Theory of nonlinear systems of ordinary differential equations:**

1. Fixed points, linearization, stability, phase plane, null clines,
2. Applications of nonlinear systems: population growth, competition and cooperation models, pharmacokinetics, epidemiology and the spread of diseases (SIR models and their extensions), disease dynamics, cancer, chemical kinetics

## SEMESTER-VII

### COURSE 19 B: MATHEMATICAL APPROACHES IN BIOLOGY

Practical

Credits: 1

2 hrs/week

#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Recollect the basic mathematical concepts
2. Get acquainted and learn solving biological problems by using MAT LAB
3. Apply the knowledge of linear and nonlinear difference equations to develop SIR models for different epidemics
4. Develop mathematical model for COVID disease spread
5. Work and develop models on pandemic or epidemic spread

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Exercises on basic mathematical concepts.
2. Introduction of MATLAB- **Input** output of data from Matlab command.
3. Creating and executing files in MAT IAB
4. Construction of bacterial growth curve graph by using MAT LAB.
5. To determine nucleotide composition using MATLAB.
6. To determine the trinucleotides (codons) code for an amino acid using MATLAB.
7. Exercises related to population growth by linear difference equations.
8. Developing a Mathematical model for Spread of COVID-19

#### VI. References:

1. Trends in Biomathematics: Chaos and Control in Epidemics, Ecosystems, and Cells: Selected Works from the 20th BIOMAT Consortium Lectures, Rio de Janeiro, Brazil, 2020 1st ed. 2021 Edition
2. Mathematical Biology: I. An Introduction: 17 edition- J.D.Murray
3. Introductory Mathematical Biology ; Author: N. Bairagi ; Publisher: U. N. Dhur& Sons
4. Practical MATLAB: With Modeling, Simulation, and Processing Projects by Irfan
5. Turk Introduction to MATLAB for Biologists (Learning Materials in Biosciences) 1st ed. 2019 Edition by Cerian Ruth Webb , Mirela Domijan

#### VII. Co-Curricular Activities

##### a) Suggested Co-Curricular Activities

1. Training of students by related industrial experts
2. Assignments on developing mathematical models for topics dealt in theory and relevant aspects and MATLAB
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on tools and techniques in Mathematical approaches in biology
5. Collection of material and data on topics covered in theory
6. Visits to Facilities, firms , research organizations etc
7. Invited lectures and presentations on related topics by field/industrial experts.
8. A survey study can be done by the students and prepare a model on spread of Flu.

**SEMESTER-VII**  
**COURSE 20 A: PHARMACoinFORMATICS**

Theory

Credits: 3

3 hrs/week

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**I Learning Objectives:**

1. To enable students learn concepts of computer aided drug design
2. To enrich knowledge on Molecular modelling and drug target docking
3. To impart knowledge on ADME of drug and New drug delivery systems

**II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Implement the knowledge in Docking and virtual screening
2. Identify pharmacophores and design drugs
3. Learn interactions in docking and simulation
4. Illustrate ADME of drug and methods of drug design
5. Explain fields of pharmacoinformatics

**III. Syllabus:** (Total Teaching Hours: 45)

**Unit 1:**

**Computer-aided Drug Design :** Concepts and Principles in CADD - 2D and 3D QSAR - Docking and protein-ligand structural recognition techniques - Virtual Screening - Molecular Dynamics - Pharmacophore generation - Advanced concepts in Structural Bioinformatics - Homology modelling: concepts, principles and application - Proteome-based technology, Introduction to drugs, Classification of drugs, Major sources of drugs.

**Unit 2:**

**Drugs :** Common filters for drugs design, Molecular descriptors, Structure activity relationship, Pharmacophore and pharmacophoric graph, Machine learning approach in designing filters; Targets of drug design: Protein as the target, structural and sequence analysis, Nucleus as target, coding and noncoding RNA, SNP analysis, other important targets.

**Unit 3:**

**Molecular modelling and simulation in drug designing:** QM and MM modelling, computation of weak interaction, docking, MD simulation-based docking;

**Unit 4:**

**Pharmacokinetics :** One-compartment model, Two-compartment model, Multi-compartment models, Pharmacokinetic parameters, Absorption, Distribution, Metabolism, Excretion, Multiple doses, Salt factor, Bioavailability. Pharmacodynamics: Drug receptor action, Direct physiological action, Drug-drug interaction, Drug potency and efficacy, Agonists and antagonists, Receptor effector coupling, Spare receptors, Therapeutic index;

**Unit 5:**

**Drug Design**

Types of drug design: Structure based, ligand based, fragment based, metabolites and their importance in drug design;

**SEMESTER-VII**  
**COURSE 20 A: PHARMACoinFORMATICS**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Work with the Toll QSAR for drug design
2. Identify interactions between ligand and proteins or substrate and proteins
3. Enhance skill in working with AutoDock for virtual screening
4. Identify and work with Pharmacophores
5. Work on Drug -target or enzyme – substrate interactions virtually

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Study of 2D QSAR in drug design
2. Study of 3D QSAR
3. Identification of drug and enzyme interactions- virtual
4. Molecular docking using AutoDock and virtual screening
5. Pharmacophore identification
6. QM modelling experiment for identification of pharmacophore
7. MM modelling experiment for identification of pharmacophore
8. ADMET model studies

**VI. References:**

1. Malone, P.M., Kier, K.L., Srtanovich, J.E. Drug Information-A Guide for Pharmacists. McGraw-Hill, 2006.
2. Krishnan Namboori P K and Deepak O M. Computational Drug Design and Delivery systems-principles and applications, Springer. 2012.
3. Prasad V. Bharatam, Modeling and Informatics in Drug Design, John Wiley & Sons Inc.2007.
4. Tagelsir Mohamed Gasmelseid, Pharmacoinformatics and Drug Discovery Technologies: Theories and Applications, IGI-Global, 2012
5. Advanced Concepts in Structural Bioinformatics: Structural Bioinformatics: Philip E. Bourne (Editor), HelgeWeissig (Editor). ISBN: 978-0-471-20199-1
6. Protein Structure Prediction: A Practical Approach (The Practical Approach Series , No 170) by Michael J. E. Sternberg
7. Computer-aided Drug Design: Practical Application of Computer-Aided Drug Design (Hardcover) by Charifson (Author)
8. Computer-Aided Drug Design. Methods and Applications. Edited by Thomas J. Perun and C.L. Propst Marcel Dekker
9. CADD virtual lab

**VII. Co-Curricular Activities**

**a) Suggested Co-Curricular Activities**

1. Training of students on drug design and drug target interactions
2. Assignments on real time targets on molecular docking
3. Seminars, Group discussions, Quiz, Debates etc

4. Preparation of videos on tools and techniques in Drug design and drug target interactions
5. Collection of material/figures/photos related to subject topics
6. Visits to.... Facilities, firms, research organizations etc
7. Invited lectures and presentations on related topics by field/industrial experts.

## SEMESTER-VII

### COURSE 20 B: DATABASE MANAGEMENT AND IMPLEMENTATION

Theory

Credits: 3

3 hrs/week

#### I Learning Objectives:

1. To enable students learn the fundamentals of DBMS
2. To impart knowledge on ER Diagram
3. To enhance knowledge on Rational modelling and Data mining

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand the fundamentals of DBMS
2. Get acquainted with entity relationship model.
3. Narrate what is Rational model and normalization
4. Illustrate concepts of Data mining and SQL
5. Explain few advanced concepts of DBMS

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

##### Fundamentals of DBMS

1. Data, Database and Database Management System; Database vs. Traditional File Systems
2. Three-Tier Architecture of DBMS, Data Independence;
3. Categories of DBMS: Hierarchical, Network and Relational Database,
4. Data and Database Models, Categories of Database Models.

##### Unit 2:

##### ER Diagram

1. Entity relationship (ER) Model
2. Basic Concepts & their Representations, Entity, Entity Type, Entity Set, Attributes and Keys, Relationships
3. Relationship Types, Structural Constraints, Weak Entity, Naming Conventions
4. Design Issues in ER Model. ER Diagrams.

##### Unit 3:

##### Introduction to Relational model and Normalization

1. Basic concepts: Domains Attributes, keys, tuples, Relations, Relational database schemas, relational Algebra operations
2. SQL in queries, views. Functional Dependencies; Normalization using Functional Dependencies – First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), and Boyce-Codd Normal Form (BCNF).

##### Unit 4:

##### Basics of Data Mining and SQL

1. Basics of data mining, related concepts, Knowledge Discovery, KDD Process
2. Data mining techniques: statistical methods, similarity measures and decision trees.  
SQL Concepts, Schema and Table Deletion; Table Modification; Insert, Delete, and Update Statements; SELECT-FROM-WHERE Structure; Renaming Attributes
3. Nested Queries and Set Comparisons

**Unit 5:****Advance concepts of DBMS**

1. Emerging database technologies and applications: Spatial databases, protein database management, Genome data management
2. Overview of Data Warehouse, OLAP, Big data, biological big data, and big data analytics.



## SEMESTER-VII

### COURSE 20 B: DATABASE MANAGEMENT AND IMPLEMENTATION

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Work in SQL environment
2. Create, update, delete databases and tables.
3. Apply the knowledge of DBMS to generate and retrieve the data from protein databases
4. Create Genome databases
5. Use SQL to create and delete views

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. SQL statements to create, update, and delete databases and tables
2. SQL statements to insert, update, and delete records from tables
3. SQL statements to create, update, and delete views
4. Simple SQL queries to retrieve information from a database
5. SQL queries using aggregate functions like count, average, sum, etc.
6. Exercises on creating database of proteins and genome

#### VI. References:

1. Connolly, T. M., & Begg, C. E. (2005). Database systems: a practical approach to design, implementation, and management. Pearson Education.
2. Dunham, M. H. (2006). Data mining: Introductory and advanced topics. Pearson Education India. Elmasri, R. (2008).
3. Fundamentals of database systems. Pearson Education India.
4. Han, J., Kamber, M., & Pei, J. (2006). Data Mining: Concepts and Techniques, (The Morgan Kaufmann Series in Data Management Systems).
5. Leon, A., & Leon, M. (2010). Database management systems. Vikas Publishing House Pvt. Limited.
6. Shinghal, R. (2012). Introduction to fuzzy logic. PHI Learning Pvt. Ltd.

#### VII. Co-Curricular Activities

##### a) Suggested Co-Curricular Activities

1. Training of students by related industrial experts
2. Assignments on creating, updating and viewing databases
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on tools and techniques in Databases management
5. Collection of material and videos for better peer group teaching
6. Visits to Facilities, firms, research organizations etc
7. Invited lectures and presentations on related topics by field/industrial experts.

**SEMESTER-VIII**  
**COURSE 21 A: IMMUNOLOGY**

Theory

Credits: 3

3 hrs/week

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**I Learning Objectives:**

1. To understand the overview of immune system,
2. To acquire sound knowledge about antigen and antibodies reactions
3. To know the immune system in health and disease

**II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Understand the immune system and types of immunity.
2. Gain knowledge of antigen and antibody and their interactions.
3. Appreciate the defence mechanisms adopted by the body.
4. Acquaint with hypersensitivity and autoimmune disorders.
5. Sound knowledge of the vaccines and their types

**III. Syllabus: (Total Teaching Hours: 45)**

**Unit 1:**

**Overview of Immune system**

1. Innate and adaptive immunity
2. Cells of the Immune system –Lymphoid cells, B-Lymphocytes, T-Lymphocytes, NK cells, Phagocytes, Granulocytes, Mast cells, Dendritic cells (outlines)
3. Organs of the Immune System –Primary and Secondary Lymphoid organs outlines

**Unit 2:**

**Immunoglobulins**

1. Structure, classes, and biological activities.
2. Humoral immune response and Cell-mediated immune responses
3. Cytokines-Interleukins (ILs) and Interferons (IFNs)

**Unit 3:**

**Antigens**

1. Immunogenicity Vs Antigenicity, Haptens, Adjuvants.
2. Antigen-antibody interactions and quantification: Antibody affinity and avidity, Precipitation reactions - Immunodiffusion, Radial immunodiffusion, double immunodiffusion; Immunoelectrophoresis, Rocket Immunoelectrophoresis,
3. Agglutination reactions - hemagglutination and Complement fixation, Immunofluorescence, ELISA, Western Blotting

**Unit 4:****The Complement system**

1. Pathways activate the complement system - the Classical complement pathway, the Alternative complement pathway,
2. Biological consequences of complement activation and Regulation.
3. Major Histocompatibility Complex-Organization and expression,
4. Antigen Processing and presentation –Cytosolic pathway, Endocytic pathway.

**Unit 5:****Hybridoma technology**

1. Production of monoclonal antibodies and their applications
2. Hypersensitivity reactions –Type I, II, III and IV (outlines)
3. Introduction to Autoimmunity
4. Introduction to Immunodeficiency disorder -AIDS
5. Vaccines- Live and Attenuated Vaccines, recombinant Vaccines and DNA Vaccines.

**SEMESTER-VIII**  
**COURSE 21 A: IMMUNOLOGY**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Develop skills to perform various immunoassays
2. Acquaint with techniques to purify immunoglobulins and the principles of blood typing.
3. Perform Ouchterlony test for comparison of antigen
4. Quantify antigens
5. Diagnose patients for Typhoid and diabetes

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Determination of A, B, O and Rh blood groups in human beings
2. Ouchterlony immunodiffusion for detection of Antigens
3. Radial Immunodiffusion
4. Immunoprecipitation and precipitin curve
5. Diagnostic test for typhoid fever
6. VDRL Test
7. Pregnancy Test

**VI. References:**

1. Kuby Immunology- Owen, Punt, 10<sup>th</sup> ed
2. Parham, The immune System, 3<sup>rd</sup> ed
3. Wiley: Roitt's Essential Immunology - Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt , 13<sup>th</sup> ed
4. Cellular and Molecular Immunology -Abul Abbas, Andrew H. Lichtman, Shiv Pillai , 9<sup>th</sup> ed
5. Fundamental Immunology - WilliumE.Paul, 7<sup>th</sup> ed
6. Janeway's Immunobiology - Kenneth Murphy and Casey Weaver, 9<sup>th</sup> ed
7. Introduction to Immunology – JohnW.Kinball , 3<sup>rd</sup> ed
8. Immunology – D.M.Weir, John Stewart, 8<sup>th</sup> ed
9. Veterinary Immunology - Ian R. Tizard, 9<sup>th</sup> ed
10. Fundamental of Immunology – Otto Bier, 2<sup>nd</sup> ed
11. Fundamentals of Immunology – William C. Boyd
12. Cellular and Molecular Immunology - Abbas, Saunders, 3<sup>rd</sup> ed

**VII. Co-Curricular Activities**

**Suggested Co-Curricular Activities**

1. Training of students by related clinical lab experts
2. Assignmentsttopics related to theory of immunology
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on theory and practical's for peer group teaching
5. Collection of material/figures/photos related to theory and experiments
6. Visits to clinical lab facilities
7. Invited lectures and presentations on related topics by field experts.

## SEMESTER-VIII

### COURSE 21 B: MEDICAL AND HEALTH INFORMATICS

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. To enable learn the scope and need of Medical and health informatics
2. To Gain the knowledge of Electronic health records and Tele medicine
3. Learn the writing of medical algorithms.

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Narrate the basics of Medical and health informatics
2. Gain expertise in creating, maintaining and retrieve the HER.
3. Learn the process and challenges in Telemedicine
4. Write medical algorithms and medical decision making
5. Learn ethics in Medical and health informatics

#### **III. Syllabus: (Total Teaching Hours: 45)**

##### **Unit 1:**

##### **Introduction to Medical and health informatics**

1. Scope and need of medical and health informatics, Health data, information and knowledge, types of health information (external versus internal),
2. Challenges in medical and health informatics

##### **Unit 2:**

##### **Electronic Health Records and Data Standards and Exchange**

1. Overview of electronic medical record (EMR) and electronic health record (EHR).
2. Personal Health Records and their implications for patients, health care providers, and health systems.

##### **Unit 3:**

##### **Telemedicine**

1. History of Telemedicine, Block diagram of telemedicine system,
2. Definition of telemedicine, Tele health, Tele care, Origin & development of telemedicine, Scope, benefits and limitation of telemedicine ,
3. Types of telemedicine , technologies used in telemedicine (AI, Block Chain, Big Data, the Internet of Medical Things)

##### **Unit 4:**

##### **Medical algorithms and medical decision making**

1. Introduction to medical algorithms, Decision-making process,
2. Medical decision-making process (diagnosis, treatment, monitoring, prognosis)
3. Informatics in clinical decision-making

##### **Unit 5:**

## **Ethics in Medical and Health informatics**

1. Ethical and legal aspects of Medical and Health informatics, Confidentiality and law,
2. Patient rights and consent, access to medical records, consent treatment, intellectual property rights, jurisdictional issue.
3. Privacy and Disposition, Legitimate Infringement, the Least Intrusive Alternative, and Accountability.

## SEMESTER-VIII

### COURSE 21 B: MEDICAL AND HEALTH INFORMATICS

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Know the ethics and policies of EHR access.
2. Gain Hands on experience of organizing the Medical and Health records.
3. Acquainted with the technology used in TeleMedicine.
4. Retrieve patient data
5. Learn representation of Medical data using bars and graphs

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Ethics, safety Guide lines of Medical and Health data Management.
2. Generating Medical data from case sheets of patients.
3. Organizing the medical data of an individual as record.
4. Exercises on retrieval of the Patients data.
5. Diagrammatical representation of Medical data (Bars and Graphs)

#### VI. References:

1. A .C. Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002
2. R. Wootton & Victor Patterson, Introduction to Telemedicine, RSM Press, 2006
3. Mohan Bansal, Medical Informatics-A Primer, Tata McGraw-Hill, 2003

#### VII. Co-Curricular Activities

##### Suggested Co-Curricular Activities

1. Training of students by related Medical health data management
2. Assignment topics related to generation of case sheets
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on theory and practical's for peer group teaching
5. Collection of material/figures/photos related to theory and experiments
6. Visits to clinical lab facilities to see medical lab report data management
7. Invited lectures and presentations on related topics by field experts.

**SEMESTER-VIII**  
**COURSE 22 A: VIROLOGY**

Theory

Credits: 3

3 hrs/week

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**I Learning Objectives:**

1. To understand about nature and properties of viruses.
2. to know about diversity, classification of Bacteriophages one step multiplication curve, lytic and lysogenic phages (lambda phage),
3. to understand about viral transmission, Salient features of viral nucleic acids and Replication.
4. to understand the concepts of oncogenes, proto-oncogenes and tumor suppressor genes.
5. To be able to gain better understanding of antiviral compounds and their mode of action, Interferon and their mode of action, General principles of viral vaccination

**II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Understand the structure and chemical composition of the Virus.
2. Know the replication of the bacteriophages.
3. Understand the concepts of cancer-causing factors.
4. gain knowledge of antiviral compounds.
5. know the role of interferons to defend virus in the host.

**III. Syllabus: (Total Teaching Hours: 45)**

**Unit 1:**

**History and Discovery of Viruses**

1. Nature, origin and evolution of viruses, New emerging and re-emerging viruses (Rota Virus, Zika Virus, Swine Flu, SARS, MERS and Covid-19), viruses in human welfare.
2. Properties of Viruses- Biological properties of viruses – host range, transmission-vector, non-vector;
3. Physical properties of viruses – morphology, structure, sedimentation, electrophoretic mobility, buoyant density
4. Biochemical characteristics – Biochemical composition of viruses (brief), Antigenic nature of viruses.

**Unit 2:**

**Nomenclature and ICTV classification**

1. Major characteristics of different virus families/genera/groups-Poxviridae, Hepadnaviridae, Adenoviridae, Herpesviridae, Ortho and Paramyxoviridae, Retroviridae, Reoviridae, Parvoviridae, Rhadboviridae, Picornaviridae (brief).
2. Algal, Fungal and Bacterial viruses- Phycodnaviridae, Cyanophages, Partitiviridae and Totiviridae. Subviral agents-sat viruses, Sat nucleic acids, Viroids, Prions (outlines).

**Unit 3:**

**Isolation, assay and maintenances of viruses**

1. **Animal, Plant and Bacterial Viruses:** General methods of cultivation of viruses-in embryonated eggs, experimental animals, cell cultures (primary and secondary cell cultures, suspension and monolayer cell cultures) and cell strains, cell lines
2. Replication of viruses –lytic cycle, lysogenic cycle. Replication strategies of DNA, RNA viruses,
3. Virus – host interactions – cytopathic effects of viral infections, inclusion bodies.



#### **Unit 4:**

##### **Virus – host interactions**

1. Cytopathic effects of viral infections, inclusion bodies.
2. Transmission of viruses – Vertical (Direct) transmission – contact, mechanical, transplacental, transovarial, sexual, fecal, oral, respiratory, seed and pollen
3. Horizontal (Indirect) transmission- aerosols, fomites, water, food, graft, dodder. Vector-arthropod, non-arthropods, virus and vector relationship.

#### **Unit 5:**

##### **Diagnosis of viral diseases**

1. Immuno diagnosis, molecular methods used in viral diagnosis, prevention and control of viral diseases,
2. vaccines and immunization control – chemoprophylaxis, chemotherapy – anti viral drugs,
3. Interferon - Interferon therapy, efficacy of infection control.

**SEMESTER-VIII**  
**COURSE 22 A: VIROLOGY**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Distinguish characteristics of normal cells and virus-infected cells.
2. Explain and apply methods used in research and diagnosis of viral diseases.
3. Describe cellular and therapeutic antiviral strategies.
4. Explore social stigmas against infected individuals.
5. Propagate and characterize viruses

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Isolation of phage from soil/sewage.
2. Cultivation and preservation of phages
3. Quantitation of phages by plaque assay
4. Growth phases of phage and burst size
5. Cultivation of animal viruses by different routes in embryonated chicken/duck eggs Yolksac, Allantoic and Chorioallantoic membrane (CAM) routes.
6. Animal cell culture-Sheep kidney cell culture, chicken embryo fibroblast cell culture
7. Mechanical inoculation of plant viruses – Tobacco mosaic virus or cucumber mosaic virus and graft transmission of plant viruses.
8. Observation of microphotographs of plant viruses, animal viruses, bacterial viruses

**VI. References:**

1. John B Carter. 2013 Virology: Principles and Applications Reviews, John Wiley & Sons, Limited, 2013 - 400 page
2. Nicholas H. Acheson, 2011. Fundamentals of Molecular Virology, 2nd Edition, McGill Univ., Canada.
3. John Carter, Venetia A. Saunders, 2007, Virology: Principles and Applications..., John Wiley and Sons.
4. Frankel-Conrat, 1994, Virology: 3rd Edition. Prentice-Hall
5. Principles of Virology: 2004 Second Edition, ASM press
6. S.J. Flint et al., 2001, Introduction to Modern Virology: 5th edition. Dimmock et al., Blackwell Sci. Publ.
7. A. Cann, 2001, Principles of Molecular Virology, 3rd edition Academic Press
8. Wagnier and Hewlett, 2004, Basic Virology, Black Well Science Publ
9. D.O. White and F.J. Fenner, 1994, Medical Virology, 4th edition. Academic Press.
10. R. Hull, 2001, Plant Virology, 4th edition by Academic Press.
11. D.M. Knipe and P.M. Howley, 2001, Fundamental Virology, 4th edition, Lippincott Williams and Wilkins.
12. Murphy et al., 1999, Veterinary Virology. 3rd edition, Academic press.
13. R.G. Webster and Allan Granoff, 1994, Encyclopedia of Virology. Vol I, II, III

**VII. Co-Curricular Activities**

**Suggested Co-Curricular Activities**

1. Training of students by related viral isolation methods
2. Assignment topics related to theory of virology
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on theory and practical's for peer group teaching
5. Collection of material/figures/photos related to theory and experiments
6. Visits to clinical lab facilities
7. Invited lectures and presentations on related topics by field experts.

## SEMESTER-VIII

### COURSE 22 B: CANCER BIOLOGY

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. To understand the the basic biology of cancer cells and carcinogenesis.
2. To acquire sound knowledge about Molecular mechanism of cancer cells.
3. To know the Different types of cancer therapies

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Understand the causes and types of Cancer.
2. Gain knowledge of factors which leads to cancer.
3. Learn the mechanisms of cell cycle regulation by Kinases.
4. Apply the knowledge of carcinogenomics to understand the cancer biology.
5. Know the different therapies to treat cancers

#### **III. Syllabus: (Total Teaching Hours: 45)**

##### **Unit 1:**

##### **Basics of Cancer biology**

1. Regulation of cell cycle, mutations, signal switches, tumour suppressor genes, modulation of cell cycle in cancer,
2. Types of cancers, diet and cancer. Cancer screening of cancer, Detection using biochemical assays, tumor markers,
3. molecular tools for early diagnosis of cancer.

##### **Unit 2:**

##### **Theory of Carcinogenesis and Metastasis**

1. Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis,
2. Principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.
3. Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion

##### **Unit 3:**

##### **Molecular cell biology of Cancer**

1. Signal targets and cancer, activation of kinases;
2. Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto oncogene activity.
3. Growth factors related to transformation. Telomerases.

##### **Unit 4:**

##### **Cancer Genomics**

1. Application of Genomics Techniques in Cancer
2. Cancer Genome Analysis, Cancer Genome Projects, Genomic Landscape of Cancer,
4. Cancer Genomics and Drug Resistance

## **Unit 5:**

### **Cancer therapy**

1. Different forms of therapy, chemotherapy,
2. Radiation therapy,
3. Targeted therapy
4. Gene therapy.

**SEMESTER-VIII**  
**COURSE 22 B: CANCER BIOLOGY**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Different techniques to identify the Cancer by using Tumor Marker tests, Microscopic, Cell proliferation tests.
2. Perform karyotyping of G banded chromosomes in patients
3. Perform cell proliferation assay
4. Separate proteins by 2D gel electrophoresis
5. Perform density gradient centrifugation

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Microscopy and Image Acquisition for Karyotyping of G Banded Chromosome of Leukemia Patients and Healthy Individuals
2. Tumor marker tests .
3. karyotyping from GTG Banded Chromosome-Chromosome identification.
4. Isolation of MNC by Density gradient Centrifugation from cell culture.
5. Gene polymorphism/ mutation/ virus detection analysis by PCR.
6. Protein separation by 2D Gel Electrophoresis.
7. Cell proliferation Assay (MTT)

**VI. References:**

1. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007
2. McDonald, F et al., "Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004.
3. King, Roger J.B. "Cancer Biology" Addison Wesley Longman, 1996.
4. Ruddon, Raymond W. "Cancer Biology" IIIrd Edition . Oxford University Press, 1995.

**VII. Co-Curricular Activities**

**Suggested Co-Curricular Activities**

1. Training of students by related subject experts
2. Assignments topics related to theory of cancer research
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on theory and practical's for peer group teaching
5. Collection of material/figures/photos related to theory and experiments
6. Visits to cancer research centers
7. Invited lectures and presentations on related topics by field experts and cancer survivors

## SEMESTER-VIII

### COURSE 23 A: DRUG DISCOVERY AND DRUG DESIGN

Theory

Credits: 3

3 hrs/week

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#### I Learning Objectives:

- To demonstrate an understanding of the environment and drivers of drug discovery and commercialisation of research
- To demonstrate an understanding of population, gender and ethnic differences in drug action and metabolism

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

- Compare and understand common natural sources of drugs and contemporary approaches to drug design and development
- Demonstrate an understanding of the timelines and resources required to discover and develop new drugs in a preclinical setting
- Demonstrate an understanding of the critical features of each stage of the preclinical drug development process
- Utilise in silico approaches to critically evaluate the pharmacophore for ligand-protein binding
- Work in small groups to design a novel drug binding to a protein target at a molecular level

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

##### Introduction- History of drug design

1. Current approaches and philosophies in drug design,
2. Molecular mechanisms of diseases and drug action with examples.
3. Pharmaceutical products of microbial origin (antibiotics) animal origin (sex hormones), plant origin (Alkaloids & Morphine).

##### Unit 2:

##### Sources of Drugs

1. Microbial drugs, Plants as a source of drugs
2. E. coli as a source of recombinant therapeutic proteins.
3. Expression of recombinant proteins in yeasts, animal cell culture systems.
4. Rational drug design and Combinatorial approaches to drug discovery

##### Unit 3:

##### Drug development process

1. Impact of genomics and related technologies upon drug discovery: Gene chips, Proteomics, Structural genomics and Pharmacogenetics.
2. Drug manufacturing process- Guides to good manufacturing practice.

**Unit 4:****Vaccines and adjuvant**

1. Attenuated and inactivated viral vaccines, Toxoids, antigen-based and other vaccine preparations.
2. Impact of genetic engineering on vaccine technology.
3. Peptide vaccines and vaccine vectors.

**Unit 5:****Nucleic acid as drugs**

1. Gene therapy: Basic approach to gene therapy,
2. Vectors used in gene therapy -Retroviral vectors, Additional viral-based vectors
3. Manufacture of viral vectors, Non-viral vectors.
4. Gene therapy and genetic disease, cancer, Gene therapy and AIDS. Gene based vaccines.

## SEMESTER-VIII

### COURSE 23 A: DRUG DISCOVERY AND DRUG DESIGN

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Describe the process of drug discovery and development
2. Identify reasons for drug resistance by bacteria due to plasmids
3. Identify antibacterial activity of actinomycetes and fungi
4. Assay antibiotics for their activity
5. Demonstrate Minimum inhibitory concentration of antibiotics

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Isolation of antibiotic producing bacteria from soil samples
2. Isolation of drug resistant plasmid from bacteria (E.coli).
3. Isolation of Actinomycetes from soil.
4. Identification of antibacterial activity of actinomycetes.
5. Identification of antibacterial activity of fungi
6. Identification of antagonistic activity of any two fungal species.
7. Assay of any one antibiotic (Penicillin).
8. Determination of MIC of any one antibiotic (penicillin / streptomycin).

#### VI. References:

1. Bhardwaj, R.K., Herrera-Ruiz, D.R., Xu, Y., Carl, S.M., Cook, T.J., Vorsa, N., and Knipp, G.T. (2008) Intestinal transporters in drug absorption. In Biopharmaceutics Applications in Drug Development (Krishna, R. and Yu, L., eds), pp. 175-261, Springer.
2. Delespaux, V. and de Koning, H.P. (2012) Transporters in antiparasitic drug development and resistance. In Antiparasitic and antibacterial drug discovery: trypanosomatidae (Flohe, L., et al., eds), pp. in press, Wiley-Blackwell.
3. Ecker, G. and Chiba, P., eds (2009) Transporters as drug carriers: structure, function, substrates. Wiley/VCH.
4. Fromm, M.F. and Kim, R.B., eds (2011) Drug Transporters. Springer.

#### VII. Co-Curricular Activities

##### Suggested Co-Curricular Activities

1. Training of students by related clinical lab experts
2. Assignments topics related to theory topics
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on theory and practical's for peer group teaching
5. Collection of material/figures/photos related to theory and experiments
6. Visits to clinical lab facilities for isolation and experiments related to animal and plant viruses
7. Invited lectures and presentations on related topics by field experts.



## SEMESTER-VIII

### COURSE 23 B: MOLECULAR AND CELLULAR TECHNIQUES

Theory

Credits: 3

3 hrs/week

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#### I. Learning Objectives:

1. To enable students understand the principles of Nucleic acid isolation
2. To impart knowledge on principles of primer synthesis and PCR techniques
3. To enhance knowledge on DNA sequencing and gene synthesis

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Perform Agarose gel electrophoresis and visualize results
2. Choose PCR type based on need and synthesize primer
3. Perform Hybridization techniques for identification of isolated biomolecules
4. Get acquainted with the next generation DNA sequencing methods
5. Purify denaturation methods and PAGE and ELISA.

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

##### Nucleic Acid Isolation techniques

1. Isolation of DNA and plasmid DNA method from bacterial cells, plants cells and animal cells.
2. Isolation of RNA and purification of mRNA.
3. Agarose gel electrophoresis and visualization of staining techniques. Pulse Field Gel Electrophoresis (PFGE).

##### Unit 2:

##### PCR techniques

1. Principles of Polymerase Chain reaction (PCR)- components of reaction.
2. Optimization of PCR, primer synthesis, gene specific and degenerate primers,
3. Hot-start PCR, ARMS-PCR, LAMP-PCR, RT-PCR and Real Time PCR.

##### Unit 3:

##### Hybridization methods

1. Introduction to probes, Radioactive probe labelling, non-radioactive probe labelling,
2. Southern hybridization
3. Northern hybridization
4. Western blotting.

##### Unit 4:

##### DNA sequencing and Gene synthesis

1. Automated DNA sequencing by Sanger's method, Pyrosequencing,
2. Next generation sequencing methods- Illumina sequencing, Single molecule real time (SMRT) sequencing, Nanopore sequencing,
3. Methods of gene synthesis.

## **Unit 5:**

### **.Protein techniques**

1. Isolation of proteins, Native Non-denaturing PAGE, Denaturing SDS PAGE, 2D gel electrophoresis, ELISA, Yeast one hybrid system,
2. Yeast two hybrid system, Page display

## SEMESTER-VIII

### COURSE 23 B: MOLECULAR AND CELLULAR TECHNIQUES

Practical

Credits: 1

2 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. The students will isolate and quantitate plasmid DNA and genomic DNA
2. Synthesize primers for PCR
3. Perform PCR for molecular diagnosis
4. Identify gene of interest and prepare a plasmid for transformation
5. Prepare competent cells and screen them...

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Isolation and characterization of Plasmid DNA and genomic DNA
2. Quantification of plasmid DNA and genomic DNA
3. Restriction digestion of plasmid DNA
4. Designing gene specific primers manually and using suitable software
5. Polymerase Chain Reaction (PCR)
6. Molecular diagnosis of SNPs using ARMS-PCR and PCR-RFLP
7. Preparation of competent cells
8. Transformation of gene and screening of transformed cells.

#### VI. References:

1. Frederick. M.A., Roger B.R, David D.M, Seidman J.G., John A.S., Kevin S., “ Current Protocols in Molecular Biology”, John Wiley and Son, Inc. 2003.
2. Daniel C.L., “ Introduction to Proteomics”, Humana Press., 2002.
3. Principles and Techniques of Biochemistry and Molecular Biology by Wilson Walker. 7<sup>th</sup> Edition, 2010.
4. Polymerase Chain Reaction: Theory and Technology. Mark A. Behlke, Kornelia Berghof-Jager, Tom Brown, et al., E.Book., 978-1-912530-25-0, Published in 2019.
5. Protein Methods, 2<sup>nd</sup> edition. Daniel M. Bollag, Michael D. Rozycki, Stuart J. Edelstein., Wiley Publishing house.

#### VII. Co-Curricular Activities

##### Suggested Co-Curricular Activities

1. Training of students by cellular and molecular technique practicals
2. Assignmentson topics related to theory of course
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on theory and practical’s for peer group teaching
5. Collection of material/figures/photos related to theory and experiments
6. Visits to facilities working on advanced aspects of subject and encourage student participation in molecular technique workshops
7. Invited lectures and presentations on related topics by field experts.

## SEMESTER-VIII

### COURSE 24 A: IMMUNOINFORMATICS

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. Learn concepts of production of Monoclonal antibodies
2. Understand sequence analysis and molecular evolution
3. Learn methods of predicting MHC class I and Class II pathways
4. Understand role of B cell epitopes in Vaccine design

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Explain about monoclonal antibody production, cell cultures and animal models.
2. Perform sequence alignments and verify viral evolution
3. Predict MHC binding with cells and their receptors
4. Work with databases for antibodies and T cell receptors
5. Explain modern ways of vaccine development

#### **III. Syllabus:** (Total Teaching Hours: 45)

##### **Unit 1:**

##### **Immunoglobulins**

1. Immunoglobulins: Structure and function-- Monoclonal antibodies.
2. B Cell generation and differentiation: BCR--Antibody diversity
3. Genetic basis—T- dependent activation of B cells-B-lymphocyte signal transduction.
4. Complement system. Antigen- antibody interaction: antibody affinity and activity- Isolation of lymphoid cells from blood and lymphoid organs.
5. Cell cultures and Experimental animal models.
6. Analysis of gene expressions.

##### **Unit 2:**

##### **Sequence Analysis**

1. Sequence Analysis: Alignments- DNA alignments- Molecular evolution and phylogeny
2. Viral evolution and escape- prediction of functions.
3. Methods applied in Immunological Bioinformatics- starting from sequence weighing
4. Methods to cluster analysis- Gibbs Sampling, HMM- Neural network- microarray and its applications

##### **Unit 3:**

##### **MHC Prediction**

1. MHC- I PREDICTION: Prediction of Cytotoxic T Cell (MHC Class I)
2. Epitopes- Antigen Processing in the MHC Class I Pathway.
3. MHC-II PREDICTION: Prediction of Helper T Cell (MHC Class II)
4. Epitopes- Processing of MHC Class II Epitopes

**Unit 4:****B cells epitope prediction and web sources**

1. Recognition of Antigen by B Cells, vaccine design - Web-Based Tools for Vaccine Design.
2. The IMGT® Immunoinformatics page.
3. Databases associated with Immunoglobulins (or Antibodies) (IG), T cell receptors (TR), Major histocompatibility (MHC), Antigens, Allergens, Peptides binding to MHC etc.

**Unit 5:****Production of Recombinant vaccines**

1. Hybridoma technology for mass production. Chimeric antibodies, antibody engineering via computational tools, large scale manufacture of antibodies.
2. Vaccine development and Immunoinformatics: Recombinant vaccines, combined vaccines, polyvalent vaccines.
3. Immunoinformatics, databases in immunology, DNA, Plant and protein based recombinant antigens as vaccines.

**SEMESTER-VIII**  
**COURSE 24 A: IMMUNOINFORMATICS**

Practical

Credits: 3

3 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Work with animal cell lines and access their resource centers
2. Compare DNA sequences
3. Construct phylogenetic trees indicating viral evolution
4. Determine motif structures
5. Perform MHC predictions using appropriate tools.

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Introduction to animal cell line and their resource centers
2. DNA sequence alignments
3. Determination of Viral evolution- Phylogeny
4. Cluster analysis techniques
5. Determination of motif by Gibbs sampling

**VI. References:**

1. "Immunological Bioinformatics" Ole Lund Darren Flower, MIT press, Springer September 2005,2006.
2. "Immunoinformatics: Predicting Immunogenicity in Silico" Darren R Flower Humana Press 2007.
3. "Immunoinformatics Bioinformatics Strategies for Better Understanding of Immune Function" Rammensee Wiley 2003.
4. Computational Immunology: Basics Shyamasree Ghosh CRC Press 2020.
5. Kuby Immunology Thomas J. Kindt , Richard A. Goldsby, Barbara A borne W. H. Freeman & Company 2006.

**VII. Co-Curricular Activities**

**Suggested Co-Curricular Activities**

1. Training of students by related experts
2. Assignments topics related to theory of immunoinformatics
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on theory and practical's for peer group teaching
5. Collection of material/figures/photos related to theory and experiments
6. Visits to research labs for exposure to advancements in the field
7. Invited lectures and presentations on related topics by field experts.

## SEMESTER-VIII

### COURSE 24 B: PYTHON PROGRAMMING

Theory

Credits: 3

3 hrs/week

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#### **I Learning Objectives:**

1. To introduce to Python
2. Learn the functions and regular expression concepts
3. To impart knowledge on lists, file objects and Bio-python

#### **II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Analyse the syntax and semantics of diverse coding elements of a Python Program
2. Select an appropriate problem-solving algorithm for a given bioinformatic problem
3. Select an appropriate data structure to store and efficiently manipulate data
4. Implement problem-solving algorithms efficiently in the Python programming language
5. Evaluate the rationale behind these problem-solving algorithms

#### **III. Syllabus:** (Total Teaching Hours: 45)

##### **Unit 1:**

##### **Introduction to python**

1. Interpreter and interactive mode Statement
2. Read and Print commands – Evaluating expressions - Decision, Boolean Logic and Repetition structures syntax with examples in biological application

##### **Unit 2:**

##### **Defining and Calling a function**

1. Fruitful functions (return value, parameters, local and global scope, function composition, recursion)
2. Examples in sequence analysis using function - Introduction to Modules.
3. Regular Expression: Importance of patterns in biology – String manipulation using regular expressions (Extraction, splitting and matching).

##### **Unit 3:**

##### **Introduction to Lists**

1. List slicing – Finding items in Lists with operator, Copying and Processing Lists – List built-in methods – Two Dimensional lists.
2. Tuples: Basic tuple operations – creation, concatenation, repetition, slicing, immutable and deletion
3. Dictionaries: creation, accessing and processing - Dictionary methods

##### **Unit 4:**

##### **File objects**

1. File built-in methods and attributes - Reading and writing files - command line arguments.
2. Exception Handling: Errors and exceptions, Detecting and Handling Exceptions

## **Unit 5:**

### **Introduction to Bio-python**

1. Installation, Inbuilt modules related to sequence objects, sequence annotation objects, sequence analysis, sequence input/output, sequence alignment objects and tools
2. Applications of Bio-python



## SEMESTER-VIII

### COURSE 24 B: PYTHON PROGRAMMING

Practical

Credits: 3

3 hrs/week

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#### IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Translate RNA sequences using python
2. Learn about fixed length matching
3. Do coding for data structures
4. Work on filing objects
5. Learn HTML processing

#### V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Translating RNA Sequencing
2. Fixed length matching
3. Coding Language to learn data structure
4. Filing objects command learning objects
5. HTML processing

#### VI. References:

1. Beazley, D. M. (2009). Python essential reference. Addison-Wesley Professional.
2. Barry, P. (2010). Head First Python. "O'Reilly Media, Inc."
3. Punch, W. F., & Enbody, R. (2010). The practice of computing using python. Addison-Wesley Publishing Company.
4. Mark, S. (2009). Programming in Python 3. Pearson Education India.
5. Lutz, M. (2013). Learning python. "O'Reilly Media, Inc."
6. Turnquist, G. L. (2011). Python Testing Cookbook. Packt Publishing Ltd.

#### VII. Co-Curricular Activities

##### Suggested Co-Curricular Activities

1. Training of students on Python programming
2. Assignment topics related to theory of the course
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on theory and practical's for peer group teaching
5. Collection of material and videos related to course
6. Visits to firms working on that area
7. Invited lectures and presentations on related topics by field experts.

**SEMESTER-VIII**  
**COURSE 25 A: PATENTING AND IPR**

Theory

Credits: 3

3 hrs/week

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**I. Learning Objectives:**

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and Applications

**II. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Understand Intellectual Property assets
2. Assist individuals and organizations in patent filing
3. Illustrate challenges in patent filing
4. Narrate patent rules
5. Explain patent filing, patent processing and patent publication

**III. Syllabus:** (Total Teaching Hours: 45)

**Unit 1:**

**Introduction to Intellectual Property Rights (IPR)**

1. Introduction to Intellectual Property Rights (IPR): Meaning of IPR,
2. Different categories of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.
3. Importance of IPR in Modern Global Economic Environment:
4. Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of Development

**Unit 2:**

**Enforcement of Intellectual Property Rights**

1. Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement .
2. **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery,
3. Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.
5. Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.

**Unit 3:**

**Basics of Patents**

1. Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions,
2. Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting,
3. Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent

**Unit 4:****Patent Rules**

1. Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario,
2. Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)

**Unit 5:****Procedure for Filing a Patent (National and International)**

1. Legislation and Salient Features, Patent Search, Drafting and Filing Patent Application.
2. Processing of patent, Patent Litigation, Patent Publication etc,
3. Time frame and cost, Patent Licensing, Patent Infringement

**SEMESTER-VIII**  
**COURSE 25 A: PATENTING AND IPR**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Perform patent search both National and International
2. Write copywrite form and verify documents
3. Verify trademarks before filing
4. Write patent documents and file them
5. Learn patent rules at National and international level

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Visiting Patent Databases- National and International
2. Copyright form document preparation and analysis
3. Trademarks retrieval and their importance
4. Patent document preparation
5. Exercising National patent submission of all types
6. Retrieving patent rules- Indian, European, Australian and Japan

**VI. References:**

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Cornish, William Rodolph&Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwellrd
5. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3 Edition, WIPO
6. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
7. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
8. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

**VII. Co-Curricular Activities**

**Suggested Co-Curricular Activities**

1. Training of students by Patent filing office personnel
2. Assignment topics related to theory of patent and IPR
3. Seminars, Group discussions, Quiz, Debates etc
4. Preparation of videos on theory on patent filing methods for peer group teaching
5. Visits to patent filing office to learn about IPR and patenting and trade marks
6. Invited lectures and presentations on related topics by field experts.

## SEMESTER-VIII

### COURSE 25 B: RESEARCH METHODOLOGY

Theory

Credits: 3

3 hrs/week

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#### I. Learning Objectives:

1. To enable them learn objectives of research and research methodologies
2. To impart knowledge on Review of literature and research design
3. Enhance knowledge on sampling, data collection and analysis

#### II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Design a research approach for a problem
2. Review the literature and develop a frame work
3. Prepare sample survey forms and Census forms
4. Evaluated the data using statistical methods
5. Write research report with proper interpretation of data

#### III. Syllabus: (Total Teaching Hours: 45)

##### Unit 1:

##### Research Methodology

1. Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Methods versus Methodology
2. Research and Scientific Method, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.
3. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

##### Unit 2:

**1. Reviewing the literature:** How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

**2. Research Design:** Meaning of Research Design, Need for Research Design, features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

##### Unit 3:

**1. Design of Sampling:** Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

**2. Measurement and Scaling:** Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale.

**3. Data Collection:** Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method

#### **Unit 4:**

##### **Testing of Hypotheses**

1. Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule
2. Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances
3. P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.
4. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

#### **Unit 5:**

##### **Interpretation and Report Writing**

1. Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing
2. Different Steps in Writing Report, Layout of the Research Report,
3. Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

**SEMESTER-VIII**  
**COURSE 25 B: RESEARCH METHODOLOGY**

Practical

Credits: 1

2 hrs/week

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**IV. Skill Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Identify research problems and write protocols
2. Design experiments
3. Conduct Surveys
4. Perform result analysis and determine nature of variables
5. Write research reports

**V. Practical Syllabus: Hours 2 hours per week= 30 hours**

1. Identifying research problem and designing protocol for its execution
2. Perform literature review from various sources
3. Experimental design for the problem
4. Generate a sample survey
5. Conduct survey and analyse the results - ANOVA
6. Identify and report independent variables, dependent variables etc
7. Report writing with proper literature review

**VI. References:**

1. Research Methodology: Methods and Techniques C.R. Kothari, Gaurav Garg, New Age International 4th Edition, 2018
2. Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2). Ranjit Kumar SAGE Publications 3rd Edition, 2011
3. Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.
4. Research Methods: the concise knowledge base W.M Trochim Atomic Dog Publishing 2005
5. Conducting Research Literature Reviews: From the Internet to Paper Fink A Sage Publications 2009.

**VII. Co-Curricular Activities**

**Suggested Co-Curricular Activities**

1. Introduce the students to the need for research
2. Make them do literature survey
3. Seminars, Group discussions, Quiz, Debates etc on research design and sampling methods
4. Preparation of videos on theory and practical's for peer group teaching
5. Collection of material and videos for better understanding
6. Visits to central libraries and make them see the book repositories
7. Invited lectures and presentations on related topics by field experts.