Choice Based Credit System

144 Credits for 3-Year UG

MAKAUT Framework

w.e.f. AY 2020-21

CURRICULUM STRUCTURE AND DETAILED SYLLABI
FOR
BACHELOR OF SCIENCE
IN
BIOINFORMATICS

Department of Bioinformatics
Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly West Bengal University of Technology)
Haringhata-741249, Nadia, West Bengal, India

Web: https://makautwb.ac.in

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Course Title:

Course Name: B.Sc. in Bioinformatics

Formal Abbreviation: BSBIN

Organizational Arrangements:

Managing Faculty: Faculty from the Department of Bioinformatics

Collaborating Faculties: Professionals from the Department of Biotechnology, Mathematics, English, Chemistry, Physics etc.

External Partners: To be decided

Maulana Abul Kalam Azad University of Technology, West Bengal
B.Sc. in Bioinformatics Program: 2021-2022

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Department of Bioinformatics
Maulana Abul Kalam Azad University of Technology, WB

Vision of the Department

To emerge as a world class center of education for building the best human resource in the Bioinformatics and allied areas through teaching, training, innovation, and research.

Mission of the Department

M1: To create opportunities for multi-disciplinary education, training, and research in the area of Bioinformatics.

M2: To educate the students to choose professions in industry, academia, and entrepreneurship.

M3: To impart environmental, legal, and ethical awareness to the students for the inclusive development of the society.

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Program Educational Objectives (PEOs)

The PEOs for the graduating students of B.Sc. in Bioinformatics program will be able to
PEO 1: Pursue basic education in Bioinformatics for future career path.
PEO 2: Flourish in their employable professional career in industry and academics.
PEO 3: Think constructively, perform teamwork along with individual professionalism, enhance entrepreneurship skills and ethical behavior.

Program Outcomes (POs)

The graduates of B.Sc. in Bioinformatics program will be able to
PO1: Apply the basic principles and concepts of biology, computer science and mathematics.
PO2: Apply existing software effectively to extract information from large databases and to use this information in computer modelling.
PO3: Equip with the laboratory skills in bioinformatics.
PO4: Develop an ability to solve, analyze and interpret data generated from the courses.
PO5: Develop written and oral communication skills to communicate effectively in a larger community.
PO6: Apply ethical principles and commit to professional ethics and responsibilities.
PO7: Perform as an individual, and as a member in diverse teams, and in multidisciplinary settings.
PO8: Design and conduct experiments, as well as to analyze and interpret scientific data.
PO9: Inculcate an attitude of enquiry towards developing innovative ability and enhancing entrepreneurship skills.
PO10: Recognize the need for, and engage in life-long learning.

Program Specific Outcome:

After successful completion of the program, the graduates of B.Sc. in Bioinformatics program shall be able to

PSO1: Acquire core knowledge and applications of the basic concepts of bioinformatics which include the major areas of cell biology, protein chemistry, bio-database and bio-tools, computer languages etc.

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PSO2: Practical exercises accompanied with theoretical studies enable students to analyze, visualize and interpret biological data as well as to draw valid inferences out of them.

PSO3: Understand the applications of statistical concepts in other interdisciplinary areas like Mathematics, Physics, Chemistry, Biotechnology, Computer Science, etc.

PSO4: Provides a strong platform for pursuing higher studies leading to Post Graduate or Research degrees as well as successful professional careers.

Nature of Development:

- a new course.

Objective:

B.Sc.in Bioinformatics (BSBIN) is one of the most sought after career oriented professional programs offered at the bachelor's level. This degree course opens up innumerable career options and opportUNITies to the aspiring bioinformatics professionals both in India and abroad. This program offers to gain knowledge about multidisciplinary science with triple major combination of biology, mathematics and computer science. The course is closely attached with analytical and numerical methods of applied biological, mathematical and computational problems to address and solve pressing challenges in all areas of science and engineering. Subjects are taught in this program with hands on experience in Bioinformatics, drug discovery, genomics and proteomics, Molecular Biology and Genetics, Microbiology and Biochemsitry, Computer programming, Biostatistics, Mathematical Modelling etc.

Course:

- Three – Year full-time B.Sc. in Bioinformatics (Six –Semester).
- Minimum number of class room-contact teaching for B.Sc. in Bioinformatics programme should be 134 credits (one credit equals 10 hours), Seminar on Emerging Area of Bioinformatics should be 02 credits, Final year Viva voice should be 02 credits and Internship / Project should be 06 credits i.e., Total 134 + 2 + 2 + 6 = 144 credits.
- Specialization: Students can opt for anyone from two Specialization; DSE 1-4 shall contribute to programme specific objectives and evaluated as project and comprehensive VIVA VOCE.

Reasons for Introduction of Course:

B.Sc. in Bioinformatics is a 3 years' professional course in combination of Biology and Computer science domain. This is a three years' full time undergraduate programme and it can also be recommended as another course like B.Sc. in Biotechnology. This proposed course is divided into six semesters and each semester will have different papers according to CBCS format. One can join the course after passing the common entrance test (CET) conducted by MAKAUT, WB. This course focuses on teaching students how to prosper in the Bioinformatics field as a professional.

Eligibility Criteria:

Interested aspirants for the course are required to fulfill the below-mentioned eligibility criteria.

- A candidate should have cleared class 12 (10+2 or equivalent) examination with English and Biology.

Notification for admission to the B.Sc. in Bioinformatics programme will be published and classes will start around the commencement of the academic session.

Admission Process:

Through CET Exam

Course Structure:

Subject type	Abbreviation	Number of courses	Credit Point	Total Credit	Credit Distribution	Mode of delivery
Core Course	CC	All 14	6	84	(Theory, Prac)	Online/Offline/ Blended
Discipline Specific Elective	DSE	All 4	6	24	(Theory, Prac)	Online/Offline/ Blended
Skill Enhancement Course	SEC	All 4	2	8	(Theory)	Online/Offline/ Blended
Generic Elective or Interdisciplinary	GE	All 4	6	24	(Theory, Prac)	Online/Offline/ Blended
Ability Enhancement Compulsory Courses	AECC	All 2	2	4	Theory	Online/Offline/ Blended
Grant Total				144		

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Subject Type	Semester I	Semester II	Semester III	Semester IV	Semester V	Semester VI
CC	CC1, CC2	CC3, CC4, CC5	CC6, CC7, CC8	CC9, CC10	CC11, CC12	CC13, CC14
DSE					DSE1, DSE2	DSE3, DSE4
GE	GE1	GE2	GE3	GE4		
AECC	AECC1	AECC2				
SEC			SEC1	SEC2	SEC3	SEC4
	4 (20)	5 (26)	5 (26)	4 (20)	5 (26)	5 (26)

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CURRICULUM STRUCTURE:

Semester I							
Sl. No.	**CBCS Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
Theory + Practical							
1	**CC-1**	**BSBINC101** **BSBINC191**	**Cell Biology** **Cell Biology Lab**	**4**	**0**	**4**	**6**
2	**CC-2**	**BSBINC102** **BSBINC192**	**Introduction to Fundamental Computer** **Fundamental Computer Lab**	**4**	**0**	**4**	**6**
3	**AECC-1**	**BSBINA101**	**English Communication Skill Development**	**2**	**0**	**0**	**2**
4	**GE-1**	**BSBING101**	**Any One from the List of** **Generic Elective /** **Interdisciplinary Courses**	**4** **/** **5**	**0** **/** **1**	**4** **/** **0**	**6**
Total Credits							**20**

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Semester II							
Sl. No.	**CBCS Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
Theory + Practical							
1	**CC-3**	**BSBINC201** **BSBINC291**	**General Microbiology** **General Microbiology Lab**	**4**	**0**	**4**	**6**
2	**CC-4**	**BSBINC202** **BSBINC292**	**Chemistry** **Chemistry Lab**	**4**	**0**	**4**	**6**
3	**CC-5**	**BSBINC203** **BSBINC293**	**C Programming Language** **C Programming Language Lab**	**4**	**0**	**4**	**6**
4	**AECC-2**	**BSBINA201**	**Introduction to Environmental Science**	**2**	**0**	**0**	**2**
5	**GE-2**	**BSBING201**	**Any One from the List of Generic Elective / Interdisciplinary Courses**	**4 / 5**	**0 / 1**	**4 / 0**	**6**
						Total Credits	**26**

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Semester III							
Sl. No.	**CBCS Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
Theory + Practical							
1	**CC-6**	**BSBINC301** **BSBINC391**	**Biochemistry and Metabolism** **Biochemistry and Metabolism Lab**	**4**	**0**	**4**	**6**
2	**CC-7**	**BSBINC302** **BSBINC392**	**Basic Physics** **Basic Physics Lab**	**4**	**0**	**4**	**6**
3	**CC-8**	**BSBINC303** **BSBINC393**	**Data Structure** **Data Structure Lab**	**4**	**0**	**4**	**6**
4	**SEC-1**	**BSBINS301** **BSBINS302** **BSBINS303**	**Enzymology** **Industrial Fermentation** **Molecular Biology**	**2**	**0**	**0**	**2**
5	**GE-3**	**BSBING301**	**Any One from the List of** **Generic Elective /** **Interdisciplinary Courses**	**4** **/** **5**	**0** **/** **1**	**4** **/** **0**	**6**
						Total Credits	**26**

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Semester IV							
Sl. No.	**CBCS Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
Theory + Practical							
1	**CC-9**	**BSBINC401** **BSBINC491**	**Basic of Bioinformatics and Methods** **Basic of Bioinformatics and Methods Lab**	**4**	**0**	**4**	**6**
2	**CC-10**	**BSBINC402** **BSBINC492**	**Bioanalytical Tools** **Bioanalytical Tools Lab**	**4**	**0**	**4**	**6**
4	**SEC-2**	**BSBINS401** **BSBINS402** **BSBINS403**	**Molecular Diagnostics** **Basic Forensic Science** **Research Methodology**	**2**	**0**	**0**	**2**
5	**GE-4**	**BSBING401**	**Any One from the List of** **Generic Elective /** **Interdisciplinary Courses**	**4** **/** **5**	**0** **/** **1**	**4** **/** **0**	**6**
					Total Credits		**20**

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Semester V							
Sl. No.	**CBCS Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
Theory + Practical							
1	**CC-11**	**BSBINC501** **BSBINC591**	**Structural Bioinformatics** **Structural Bioinformatics Lab**	**4**	**0**	**4**	**6**
2	**CC-12**	**BSBINC502** **BSBINC592**	**Programming in Python** **Programming in Python Lab**	**4**	**0**	**4**	**6**
4	**DSE-1**	**BSBIND501**	**Elective-I** A. **Biostatistics** B. **Plant Biotechnology** C. **Medical Biotechnology**	**4 / 5**	**0 / 1**	**4 / 0**	**6**
5	**DSE-2**	**BSBIND502**	**Elective-II** A. **Linux & Shell Scripts** B. **Genomes to Drug and Vaccine**	**4 / 5**	**0 / 1**	**4 / 0**	**6**
Sessional							
6	**SEC-3**	**BSBINS581**	**Seminar on Emerging Area of Bioinformatics**	**2**	**0**	**0**	**2**
						Total Credits	**26**

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Semester VI							
Sl. No.	**CBCS Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
Theory + Practical							
1	**CC-13**	**BSBINC601** **BSBINC691**	**Immunology** **Immunology Lab**	**4**	**0**	**4**	**6**
2	**CC-14**	**BSBINC602** **BSBINC692**	**Data Analysis with R** **Data Analysis with R Lab**	**4**	**0**	**4**	**6**
4	**DSE-3**	**BSBIND601**	**Elective-I** A. **IPR, Biosafety and Ethical Issues** B. **Environmental Biotechnology**	**4 / 5**	**0 / 1**	**4 / 0**	**6**
5	**DSE-4**	**BSBIND682**	**Elective-II** **Project/ Dissertation**	**4 / 5**	**0 / 1**	**4 / 0**	**6**
Sessional							
6	**SEC-4**	**BSBINS681**	**Comprehensive viva**	**0**	**0**	**0**	**2**
						Total Credits	**26**

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SEMESTER	CREDITS
I	20
II	26
III	26
IV	20
V	26
VI	26
TOTAL	144

List of General Elective papers –Interdisciplinary:

GE1	Basic Mathematics
GE2	Introduction to Probability-Statistics
GE3	Biomathematics
GE4	Plant and Animal Tissue Culture
GE5	Biotechnology and Human Welfare
GE6	Numerical Methods
GE7	Inheritance Biology

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GE8	Ecology and Environmental Management
GE9	Entrepreneurship Development
GE10	Genetics

Detailed Syllabi of B.Sc. in Bioinformatics Program: 2021-2022

Subject Name: Cell Biology	**Category:** CC-1
Subject Code: BSBINC101	**Semester:** 1
L-T-P: 4-0-0	**Credit:** 4

Course Outcomes:

By the end of this course students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINC101.1: Identify strong foundations of different structures, functions, compartmentalization of various cell organelles in a cell.	I
2	BSBINC101.2: Describe basic processes of the cell like protein secretion, segregation and about the support system of the cell.	II
3	BSBINC101.3: Demonstrate some specific biogenesis of organelles and their genome organization	III
4	BSBINC101.4: Interpret cell division, cell death mechanism, cancer and its process of generation.	IV

Course Contents:

UNIT I (16L)
Basics of Cell Biology (structure & function) – Discovery of cell and Cell Theory; Comparison between plant and animal cells; cytosol, compartmentalization of eukaryotic cells, cell fractionation.
Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.
Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex;

UNIT II (12L)
Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III (12L)
Lysosomes: Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.

UNIT IV (20L)
Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extracellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.
Cell cycle - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division, Programmed cell death (Apoptosis), intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer,
Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Learning Resources:

1. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition,Pearson Benjamin Cummings Publishing, San Francisco

2. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
3. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
4. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

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Practical

Subject Name: Cell Biology Lab	**Category:** CC-1
Subject Code: BSBINC191	**Semester:** 1
L-T-P: 0-0-4	**Credit:** 2

Course Outcomes:
BSBINC191.1: Experiments with basic processes of cells by applying techniques.
BSBINC191.2: Summarize results.
BSBINC191.3: Illustrate the results and present a scientific report.

Course Contents:

1. Preparation of Mitotic Chromosome from onion root tip.
3. Preparation of Meiotic Chromosome from Rhoeo discolor or onion sp.
4. Preparation and study of polytene chromosomes from Drosophila salivary gland.
5. Study of sex chromatin through preparation of Barr body from buccal epithelium.
6. Study of chromosomal aberration induced by pesticide in onion root tips.
7. Study of plasmolysis and de-plasmolysis.

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

Learning Resources:
1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

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Subject Name: Introduction to Fundamental Computer	**Category:** CC-2
Subject Code: BSBINC102	**Semester:** 1
L-T-P: 4-0-0	**Credit:** 4

Course Outcomes:

Sl No	Course Outcome	Mapped Unit
1	BSBINC102.1: Demonstrate a basic understanding of the generation of computers with classification and components.	I
2	BSBINC102.2: Recognize the importance of Operating Systems, like process management, deadlocks, memory management, device management and file system.	II
3	BSBINC102.3: Illustrate and apply the skills of various positional number systems, logic gates and Boolean function in the digital logic design field	III

Course Contents:

UNIT I (6L)
Basic concept of Computer System Introduction, Characteristics of Computer, Components of Computer, Basic organization of Computer System (I/P, O/P, Memory & CPU UNITs). Generation of Computer: 1st to 4th generations with characteristics, Classification of computer systems.

UNIT II (20L)
Operating System Introduction: What operation systems do? Operations of OS. Evolution of OS – Batch processing, Multiprogramming, Time sharing, Distributed.
Process Management: Process concept, Process States, Process control block (PCB) Process scheduling: Schedulers (long-term, short-term and medium-term), Context switching, scheduling criteria, scheduling algorithms (FCFS, SJF, Priority, RR), Multilevel Queue scheduling and

Multilevel Feedback Queue scheduling.
Threads: Concept, Models, Multi-threading example (word processor).
Process Synchronization: Cooperating process, Critical-Section problem and solution, Semaphores (Binary & counting).
Deadlocks: Concept, Resource Allocation Graph, Necessary conditions for Deadlock, Handling
deadlocks: Deadlock prevention and avoidance. Concept of Banker's algorithm with example, Deadlock recovery.
Memory management: Memory management concept, Memory allocation rule, Swapping, Overlay, Paging, Demand paging, segmentation, virtual memory. Device management, File management.

UNIT III (15L)

Digital Logic Number System: Positional & Non-Positional, Representation of positional number system, Classification of positional number system (Decimal, Binary, Octal, Hexadecimal).
Inter-conversion: among known and unknown bases.
Digital Logic: addition, subtraction, multiplication, division, r's complement & (r-1)'s complement.
Boolean Algebra & Logic Gates Basic laws and postulates, Huntington postulates, Duality.
Logic Gates: AND, OR, NOT, NAND, NOR, XOR & XNOR with truth table.
Boolean Functions: Representation (Boolean expression, Truth Table & Circuit Diagram), Canonical Form (SOP, POS), Conversion between canonical forms.

Learning Resources:

1. Computer Fundamentals – by R.S. Salaria, Khanna Publishing House
2. Computer Fundamentals – by Pradeep K Sinha, Priti Sinha
3. Operating System Concepts – by Abraham Silberschatz, Peter B. Galvin, Gerg Gange
4. Operating System Concepts – by Ekta Walia, Khanna Publishing House
5. Operating System – by P. Bala Krishna Prasad
6. Digital Design - by M. Morris R. Mano (Author), Michael D. Ciletti (Author)
7. Digital Logic and Computer Design – by M. Morris Mano

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Practical

Subject Name: Fundamental Computer Lab	**Category:** CC-2
Subject Code: BSBINC192	**Semester:** 1
L-T-P: 0-0-4	**Credit:** 2

Course Outcomes:

BSBINC192.1: Apply Microsoft Word to solve different word processing related problems.
BSBINC192.2: Apply Microsoft Excel to solve different Spreadsheet related problems.
BSBINC192.3: Apply Microsoft powerpoint to solve different presentation related problems.
BSBINC192.4: Apply the usage of MS-DOS commands.

Course Contents:

UNIT I (12L)
Usage of MS-DOS commands: basic concepts of internal & external commands, directory and file commands, copying, erasing, renaming, displaying files, introduction to pipes & filters, concept of batch file.

UNIT II (8L)
Microsoft word- concept of toolbar, character, paragraph & document formatting, drawing toolbar, header, footer, document editing, page setup.

UNIT III (12L)
Microsoft excel- concept of spreadsheets, creating worksheet, well formatted document, concept of row, column, cell & formula bar, using function, using shortcuts, charts, goal, validation rule.

UNIT IV (8L)
Microsoft powerpoint presentation- slide layout & design, custom animation, image importing, slide transition

Learning Resources:

1. Computer Fundamentals – by R.S. Salaria, Khanna Publishing House
2. Computer Fundamentals – by Pradeep K Sinha, Priti Sinha
3. Operating System Concepts – by Abraham Silberschatz, Peter B. Galvin, Gerg Gange
4. Operating System Concepts – by Ekta Walia, Khanna Publishing House
5. Operating System – by P. Bala Krishna Prasad
6. Digital Design - by M. Morris R. Mano (Author), Michael D. Ciletti (Author)
7. Digital Logic and Computer Design – by M. Morris Mano

Subject Name: English Communication Skill Development	**Category:** AECC-1
Subject Code: BSBINA101	**Semester:** 1
L-T-P: 2-0-0	**Credit:** 2

Course Outcomes:

Sl No	Course Outcome	Mapped Unit
1	BSBINA101.1: Relate the importance of listening and comprehending oral communication.	I
2	BSBINA101.2: Recognize the difference between in depth reading and casual reading.	II
3	BSBINA101.3: Explain the art of Oral Communication and its implication in organizational context.	III
4	BSBINA101.4: Demonstrate about writing letters, notices, circulars and other written communication.	IV, V
5	BSBINA101.5: prepare for interviews and deliver effective presentations.	VI

Course Contents:

UNIT I (2L)
Listening & Understanding Lessons: Types and process of Listening, Importance of Listening, Aural comprehension

UNIT II (2L)
Reading Skill: Intensive and Extensive Reading, Skimming and Scanning

UNIT III (4L)

Communication Skill: Elements of Spoken English, Conversation Practice, Debates, and Colloquium

UNIT IV (6L)
Writing Skill: Basic Rules, Introductory Grammar, Common Errors Writing CVs, Official Correspondence, Letter for approval of the authority,

Circular, Agenda, Notice, Press Release, Report writing about the proceedings of any seminar, Preparation of official reports, etc.

UNIT V (4L)
Topic of discourse, mode of discourse and style of discourse with special reference to scientific discourse.

UNIT VI (2L)
Personality Grooming: Mock Interview, Group Discussions and Seminar Presentations, Role play.

Tutorial for each topic. (5L) Tutorial

Tutorial and assignments on all language activities and communicative tasks- group discussion, seminar

Learning Resources:

1. Nilanjana Gupta, Communicate with confidence, Anthem Press

2. V. Syamala, Effective English Communication for you, Emerald Publisher

3. Krishnamohan & Meera Banerji, Developing Communication Skills

4. R. K. Madhukar, Business Communication, Vikash Publishing House Pvt. Ltd.

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Subject Name: General Microbiology	**Category:** CC-3
Subject Code: BSBINC201	**Semester:** 2
L-T-P: 4-0-0	**Credit:** 4

Course Outcomes:

Sl No	Course Outcome	Mapped Unit
1	BSBINC201.1: Summarize historical development and contributions of various scientists in the field of Microbiology and classify microbes.	I
2	BSBINC201.2: Distinguish different staining procedures in microbiological experiments.	II
3	BSBINC201.3: Describe microbial growth, different metabolic pathways along with various genetic exchange processes in bacteria.	III
4	BSBINC201.4: Show the industrial applications of microbes especially in food, fermentation industry and also significance of water microbiology.	IV

Course Contents:

UNIT I (10L)
Overview of history of Microbiology - Biogenesis and abiogenesis Contributions of Redi, Spallanzani, Needham, Pasteur, Tyndal, Joseph Lister, Koch [Germ Theory], Edward Jenner and Flemming [Penicillin], Scope of Microbiology. Classification of Microbes - Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of classification of microorganisms Systematics of bacteria, General properties of Archae and Eubacteria

UNIT II (6L) Staining: Concept of auxochrome, chromophore, dyes, Mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella and endospore staining

UNIT III (15L)

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Nutritional types [Definition and examples]. Classification on the basis of oxygen requirement Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV (14L)

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.
Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods (Yoghurt, cheese, Idli, Kinema).

Learning Resources:

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition.ohn and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Practical

Subject Name: Lab on General Microbiology	**Category:** CC-3
Subject Code: BSBINC291	**Semester:** 2
L-T-P: 0-0-4	**Credit:** 2

Course Outcomes:

BSBINC291.1: Understand basic microbiological techniques and experimental procedures to execute experiments in Microbiology.
BSBINC291.2: Apply different staining procedures.
BSBINC291.3: Interpret results and present scientific reports.

Course Contents:

1. Sampling and quantification of microorganisms in air, soil and water.
2. Isolation of bacteria [Streak plate, spread plate, pour plate, serial dilution]
3. Identification of microorganisms from the habitats [simple staining, differential staining, acid fast staining, capsule staining, spore staining and motility]
4. Observation of morphology - shape and arrangement of cells.
5. Methods of inoculation of different microbes in selective media.
6. Microscopic measurements, micrometer (ocular and stage),
7. Enumeration of microorganism - total & viable count

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

Learning Resources:

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition.ohn and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Subject Name: Chemistry	**Category:** CC-4
Subject Code: BSBINC202	**Semester:** 2
L-T-P: 4-0-0	**Credit:** 4

Course Outcomes:

Sl No	Course Outcome	Mapped Unit
1	BSBINC202.1: Identify the firm foundation of basic chemistry.	I
2	BSBINC202.2: Explain the chemical reactions and strategies to balance them, relative quantities of reactants and products, fundamentals of acid/base, atomic structure, radioactivity and nuclear structure of atoms etc.	I, II
3	BSBINC202.3: Illustrate the Nomenclature and bonding in organic compound, Alkane, alkenes, alkynes, Aromatic Hydrocarbon, Stereochemistry, Alcohols, Ethers and Phenols, Aldehydes and ketones, carboxylic acid and their derivatives etc.	II, III
4	BSBINC202.4: Apply the concept in problem solving, analytical reasoning as applied to scientific problems.	III

Course Contents:

UNIT I (10L)
Atomic Structure, radioactivity and Nuclear Structure of Atoms:
Bohr's atomic model & limitation. Idea of de Broglie matter weaves. Hisenberg's uncertainty principle. Schrodinger's wave equation. Significance of wave function. Quantum numbers. Multielectron System-Pauli's exclusion principle, Hunds rules of maximum multiplicity. Stability of half-filled and full field orbitals, Afbau principle & its limitation. Electronic configuration of atoms. Radioactive disintegration series, group displacement law, law of radioactive decay, half-life and average life of radio elements, radioactive equilibrium, measurement of

radioactivity. Stability of atomic nucleus, n/p ratio. Radioisotopes and their application: Determination of age of earth, radiocarbon dating, Medicinal and agriculture use of isotopes, hazards of radioactivity.

UNIT II (16L)

Chemical Bonding and Structure:

(a) Ionic Bonding: General characteristics of ionic compounds: ionization energy, electron affinity etc. Sizes of ions, radius ratio rule and its limitation. Lattice energy, Born-Haber cycle.

(b) Covalent Bonding: General characteristics of covalent compounds, valence bond approach, directional character of covalent bond, hybridization involving s-, p- and d- orbitals. Valence State Electron Pair Repulsion (VSEPR) concept, shapes of simple molecules and ions. Fajan's Rules. Hydrogen bonding and its effect on physical and chemical properties. Other types of molecular interaction.

Acids-Bases and Solvents:

Modern concepts of acids and bases: Arrhenius theory, theory of solvent system, Bronsted and Lowry's concept, Lewis concept with typical examples, applications and limitations. Strengths of acids and bases (elementary idea). Ionization of weak acids and bases in aqueous solution, ionization constants, ionic product of water, pH scale

Nomenclature and Bonding in organic compounds:

Classification, trivial names and IUPAC system of nomenclature of organic compounds. Nature of covalent bond and its orbital representation. Hybridization, bond energy, polarity of bond & dipole moment of molecules, inductive effect, hydrogen bond, conjugation, resonance. Haemolytic & heterolytic fission of bonds electrophiles & nucleophiles, carbocation, carbanions and radicals- their stability, geometry & generation.

UNIT III (14L)

Alkanes, Alkenes, Alkynes:

Isomerism, synthesis , chemical reactivity of alkanes, Mechanism of free radical halogenation of alkanes, sulphonation of alkanes. Chemical reactivity, hydrogenation, heat of hydrogenation and stability of alkanes, electrophilic addition reaction & mechanism, halogenation, hydrohalogenation, hydration, hydroboration, Markownikoffs rule, peroxide effect, 1-3 dipolar addition (only formation no details mechanism is required). Alkyne synthesis hydration, substitution reactions, polymerization. Mechanism of SN1 & SN2 reaction, E1&E2 reaction (elementary treatment) of aliphatic hydrocarbon. Saytzeff& Hofmann elimination.

Aromatics Hydrocarbons and Aromatic substitution reactions :

Isomerism of aromatic compounds, their nomenclature, structure of benzene ring. General mechanism of aromatic electrophilic substitution (elementary treatment) Methods of synthesis, nitration, Sulphonation, halogenation. Friedel-crafts alkylation and acylation, reaction, nuclear and side chain halogination. Mechanism of Nucleophilic and electrophilic aromatic substitution.

Stereochemistry:

Dissymmetric Molecules: Different types of Isomerism, Structural Isomers, Geometrical, Stereoisomerism, Configurational Isomers,

Conformational Isomers, Concept of asymmetric carbon atom, Enantiomers, Diastereiosmers, Stereo genic atom / center, Chirotopic / Achirotopic Centre, Protereoisomerism, Concept of Topicity of Ligands and Faces (Homotopic, Enantiotopic, Diastereotopic atoms and groups; Prochiral, Homotopic, Enantiotropy, Diastereotopic Faces), Projection Structures of Streoisomers (Fischer, Sawhorse, Newman, Flying-Wedge projection and Interconversion of these projections formulas) of simple molecules containing one or two asymmetric carbon atom, Optical isomerism, Optical activity, Element of symmetry and chirality, Meso compounds, Chiral centers and the number of stereoisomers, Racemic modifications, Racemic mixture or (+/-)-Conglomerate, Racemic Compounds or racenate, Stereo chemical nomenclature of Stereoisomers containing chiral centers(R/S and E/Z or cis-trans or sec cis- sec trans of C=C system);D,L system of designation; Pro-R, Pro-S, Re, Si, Erythro, threo, Pref and Praf designation of enantiotropy groups and atoms; Chirality of Organic molecules without chiral center and concept of chiral axis.

Alcohols, Ethers and phenols:

Methods of synthesis, physical properties, distinction of primary, secondary and tertiary alcohols. Chemical reactivity. Ethers, methods of synthesis, Chemical reactivity. physical properties: acidic character of phenols, chemical reaction –Reimer-Tiemann reaction, Fries rearrangement, Kolbe's reaction, phenol formaldehyde resins (Lederer-Manasse reaction) Cresols, nitro and amino phenols. (Synthesis only).

Aldehydes and ketones: Methods of synthesis of aldehydes and ketones, chemical reactivity of carbonyl group, cannizzaro reaction and aldol condensation, relative reactivities of aldehyde and ketones. Perking reaction, benzoine condensation, Claisen condensation.

Carboxylic acid and their derivatives:

Methods of synthesis, acidity of aliphatic and aromatic acid, effects of substituents on acidity (simple cases). Chemical reactivity. Mechanism of esterification. Methods of synthesis and reaction of acid halides, amides, esters and anhydrides.

Learning Resources:

1. Inorganic Chemistry by R. L. Dutta
2. Organic Chemistry by I. L. Finer (Vol. I)
3. Advanced practical chemistry, 3rd edition by Subhas C Das
4. An advanced course in practical chemistry by Ghoshal, Mahapatra and Nad.
5. Engineering Chemistry by Satyaprakash & Manisha Agarwal (Khanna)

Practical

Subject Name: Lab on Chemistry	**Category:** CC-4
Subject Code: BSBINC292	**Semester:** 2
L-T-P: 0-0-4	**Credit:** 2

Course Outcomes:

BSBINC292.1: Understand the common laboratory techniques.
BSBINC292.2: Apply the concept of the scientific method to create, test and evaluate the given experiments.
BSBINC292.3: Examine the outcome of organic reactions using a basic understanding of the functional groups.

Course Contents:

1. Qualitative organic analysis: Detection of elements (N,S,Cl,Br,I), unsaturation & all the functional groups (alcoholic & phenolic hydroxyl/ aldehydic & ketonic carbonyl / carboxylic acid & aromatic amino, anilide and nitro) present in a supplied mono- or bi- functional organic compounds. (20 L)
2. Gravimetric Analysis: Techniques of Precipitations, filtration, washing, drying, igniting and weighing precipitates. Gravimatric estimation of any ion. Determination of hardness water. Estimation of glucose & phenol. sulphaides, sulphites, sulphates, nitrites, nitrates, nitrites, & phosphates, (Acid insoluble compounds & phosphate separation omitted). (20 L)

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

Learning Resources:

1. Inorganic Chemistry by R. L. Dutta
2. Organic Chemistry by I. L. Finer (Vol. I)
3. Advanced practical chemistry, 3rd edition by Subhas C Das
4. An advanced course in practical chemistry by Ghoshal, Mahapatra and Nad.
5. Engineering Chemistry by Satyaprakash & Manisha Agarwal (Khanna)

Subject Name: C Programming Language	**Category: CC-5**
Subject Code: BSBINC203	**Semester: 2**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes:

Sl No	Course Outcome	Mapped Unit
1	BSBINC203.1: Describe the basic concepts of algorithm and programming.	I
2	BSBINC203.2: Describe and apply several operators, types and control structures used in programming.	II
3	BSBINC203.3: Describe and apply the concepts of array, function, pointer etc.	III
4	BSBINC203.4: Describe and apply the concepts of String, Structure & Union and File concept.	IV

Course Contents:

UNIT I (8L)
Programming Language concepts & Introduction to C. C character set, Constants, variables and keywords. Type of variables & constants. Rules of constructing variable identifiers. Concept of algorithm and flowchart.
UNIT II (16L)
Types of C Instructions (Type declaration, Arithmetic & Control Instructions), Data Types, Operators, Hierarchy of operators, Associativity of operators, Type conversion (explicit and implicit), Control Instructions: if-else, switch case, conditional operator. Loops (for, while, do-while). break & continue statement.
UNIT III (12L)
Array: one-dimensional & multi-dimensional (2D) array. Function and pointer: Prototype, definition and calling of function, Recursive functions, Call-by-value & Call-by-reference, passing array to function. Pointer concept, pointer to pointer, pointer operations, pointer and array.
UNIT IV (14L)
C Preprocessor: Concept, File inclusion & Macro expansion, Symbolic constants. Type modifiers (long, short & signed), Storage class (auto, extern, static & register). String: Pointer and String, Standard library functions (strlen(), strcpy(), strcmp(), strcat()). Structure and Union, Self-referential structure. File handling: File opening modes, reading from file, writing into file.

Learning Resources:

1. Problem Solving & Programming in C – by R.S. Salaria (Khanna)
2. Programming with C – by Byron Gottfried
3. Let Us C -by Yashavant P. Kanetkar

Practical

Subject Name: C Programming Language Lab	**Category: CC-5**
Subject Code: BSBINC293	**Semester:**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes:

BSBINC293.1: *Apply* basic syntax of C language to solve simple problems.
BSBINC293.2: *Apply* C language syntax to solve operators, data types and control structures related problems.
BSBINC293.3: *Apply* C language syntax to solve array, function, pointer related problems.
BSBINC293.4: *Apply* C language syntax to solve String, Structure & Union and File concept related problems.

Course Contents:

1. Write a program, which will take marks of five subject of a student and will give the output as sum & percentage of marks.
2. Write a program to determine inputted integer is even or odd.
3. Write a program to calculate sum of digits of an inputted integer.
4. Write a program to find reverse of an inputted integer. 5. Write a program to find weather given integer is palindrome or not.
6. Write a program which will calculate the electricity bill on the basis of following condition:
Bill amount = 1000 if UNITs < 500, Bill amount = 1000 + 2*(UNITs – 1000) if UNITs in between 500 and 1000, Bill amount = 1000 + 3*(UNITs – 1000) if UNITs is more than 1000.
7. Write programs to display following patterns based on height: 8. Write a program to find factorial of given positive integer.
9. Find the sum of several series up to nth term:
10. Write a program to calculate, where x and y are positive integers.
11. Find the sum of following series up to nth term:

12. Write a program to determine whether an inputted integer is prime or not.
13. Write a recursive function to calculate the factorial of a given positive integer.
14. Write a recursive function to obtain the first N numbers of a Fibonacci series.
15. Write a program to check whether a given string is palindrome or not [use strcmp() function].
16. Write a menu driven program which has following options:
    a. Factorial of a number. b. Prime or not. c. Odd or even. d. Exit.
17. Write a program to obtain the transpose of a matrix. [Hints: The transpose of a matrix is obtained by exchanging the elements of each row with the elements of the corresponding column].
18. Write a program, which will produce an output to show student details (roll, name, city, phone number, and department) from an institution.
19. Write a program to calculate the number of characters, words, blanks, tabs & lines in a given text file.
20. Write a program to copy the content of a given text file into a newly created file.
21. etc.

Learning Resources:

1. Problem Solving & Programming in C – by R.S. Salaria (Khanna)
2. Programming with C – by Byron Gottfried
3. Let Us C -by Yashavant P. Kanetkar

Subject Name: Introduction to Environmental Science	**Category: AECC-2**
Subject Code: BSBINA201	**Semester: 2**
L-T-P: 4-0-0	**Credit: 2**

Course Outcomes:

Sl No	Course Outcome	Mapped Unit
1	BSBINA201.1: Demonstrate the basic concepts of environmental science as a medium for global welfare and creating the key components involved in environmental processes.	I
2	BSBINA201.2: Describe the resource utilization, conservation and management domains, Enumerate energy manifestation technologies.	II
3	BSBINA201.3: Describe the established environmental concerns and generate awareness of laws in the field of environment.	III
4	BSBINA201.4: Illustrate the linking of social sciences with different environmental problems.	IV

Course Contents:

UNIT I (10 L)
Introduction to environmental studies & ecosystems: Multidisciplinary nature of environmental studies: Scope and importance; what is an ecosystem? The structure and function of ecosystem, Energy flow in an ecosystem, food chains, food webs and ecological succession, forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems; Levels of biological diversity such as genetic, species and ecosystem diversity; biogeography zones of India, biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation, endangered and endemic species of India, threats to biodiversity, habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions, conservation of biodiversity, in-situ and exsitu conservation of biodiversity, concept of sustainability and sustainable development.

UNIT II (15 L)
Natural resources & its management and conservation: Land resources and land use change: Land degradation, soil erosion and desertification; Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations; Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state); Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources and growing energy needs.

UNIT III (10 L)

Environmental pollution & management: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, Solid waste management: Control measures of urban and industrial waste. Climate change, global warming, ozone layer depletion, acid rain and their impact on human commUNITies and agriculture. Environment Laws: Environment Protection Act, Air (Prevention & Control of Pollution) Act, Water (Prevention and control of pollution) Act, Wildlife Protection Act, Forest Conservation Act; International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD); Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

UNIT IV (6 L)

Environment & social issues: Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; environmental communication and public awareness.

Learning Resources:

1. M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House
2. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
3. O.P. Gupta, Elements of Environmental Pollution Control, Khanna Publishing House
4. Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
5. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
6. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
7. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
8. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science,339: 36-37.
9. McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29-64). Zed Books.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science, Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley
13. Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
14. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and
16. Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York: Norton.
17. World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press

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Semester 3

Subject Name: Biochemistry and Metabolism	**Category: CC-6**
Subject Code: BSBINC301	**Semester: 3**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINC301.1: Outline the concept about the structure of carbohydrate, amino acids and higher order structure of proteins	I
2	BSBINC301.2: Explain the structure of lipids and categorize the genetic materials of living organisms.	II
3	BSBINC301.3: Illustrate the mechanism of activities of different types of enzymes.	III
4	BSBINC301.4: Discuss the energetics of living organisms by studying metabolism of carbohydrates and lipids.	IV
5	BSBINC301.5: Summarize the role of metabolism of amino acids and nucleotides to produce different functional molecules in the biological system.	IV

Course Contents:

UNIT I (12 L)

Introduction to Biochemistry: A historical prospective.

Carbohydrates: Structural aspects – Introduction & Occurrence, Classification of Mono-, Diand Polysaccharides, Reducing & Non-reducing Sugars, Constitution of Glucose & Fructose, Osazone formation, Pyranose & Furanose forms, Determination of ring size, Inter-conversion of monosaccharides.

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

UNIT II (12 L)

Lipids: Structural aspects – General introduction, Classification & Structure of Simple & Compound lipids, Properties of Lipid aggregates (elementary idea), Biological membrane,

membrane protein – structural aspects, Lipoproteins (elementary idea).

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT III (8 L)

Chemical & Enzymatic Kinetics - An introduction to enzyme; How enzyme works; Reaction rate; Thermodynamic definitions; Principles of catalytic power and specificity of enzymes;

Enzyme kinetics – Approach to mechanism.

UNIT IV (8 L)

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenosis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

Lipid Metabolism – Structures and roles of Fatty acids & Glycerols, beta oxidation of saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, energy yield, Ketone bodies.

Amino acid Metabolism – Amino acid breakdown (amino acid deamination, Urea cycle,

metabolic breakdown of individual amino acids – glucogenic & ketogenic amino acids), amino acids as biosynthetic precursors (haem biosynthesis & degradation, biosynthesis of epinephrine, dopamine, seretonin, GABA, histamin, glutathione); biosynthesis of essential & non-essential amino acids. Nucleotide Metabolism – biosynthesis of purine & pyrimidine (de novo & salvage pathway); degradation of purine & pyrimidine.

Learning Resources:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.

Practical

Subject Name: Biochemistry and Metabolism Lab	**Category: CC-6**
Subject Code: BSBINC391	**Semester: 3**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes:

BSBINC391.1: Understand and analyze the structures of biomolecules using computational tools.
BSBINC391.2: Measuring H-bonds in the protein structures.
BSBINC391.3: Analyze of Ramachandran plot and protein secondary structure.
BSBINC391.4: Apply computational tools to analyze structures of Carbohydrates and lipids.

Course Contents:

1. Introduction of biochemistry laboratory and basic idea of bio-molecules using computational methods.
2. Structure visualization of amino acids and its computational nomenclature.
3. Display the protein structure in front, top, bottom, and left view.
4. Leveling the amino acids in group name, atomic name, and atomic charges.
5. Stereo view and analysis of protein.
6. Display the colour of protein structure using CPK model, residue type, RMS, B-factor, secondary structure, specific selection type, specific chain of the protein molecules, protein backbone and side chains, ribbon shape, and protein surface.
7. Display the protein structure using rendering method in solid 3D form.
8. Identification of acid, basic, polar, and non polar amino acids in protein structure.
9. Identification and analyzing the secondary structures of protein.

10. Identification of amino acids within 3.5Å from specific region of protein, amino acids in making clashes, amino acids in making clashes with backbone, and side-chain of protein lacking proper H-bonds.
11. Investigation of specific or selective amino acids in protein.
12. Tracing CA atoms and backbone atoms of the protein structure
13. Display and measure the peptide bonds of protein
14. Calculation of H-bonds in the protein structures
15. Displaying and analyzing the Ramachandran plot of protein.
16. Visualizing and analyzing structure of Monosaccharides, Oligosaccharides, and Polysaccharides.
17. Identify functional groups of carbohydrates.
18. Label the carbohydrates as either D- or L-enantiomers.
19. Structure representation of different lipid - LIPID MAPS.
20. Presentation of Glycans in Glycosphingolipids
21. Online tools and structure drawing of lipids.

Learning Resources:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.

Subject Name: Basic Physics	**Category: CC-7**
Subject Code: BSBINC302	**Semester: 3**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINC302.1: Recognize the concepts and functionalities of the electronic devices.	I, II

2	BSBINC302.2: Explain diffraction and its practical applications, introduced to the principles of lasers, types of lasers and their applications.	III
3	BSBINC302.3: Describe some of the basic laws related to quantum mechanics as well as associated quantum mechanics calculations.	IV

Course Contents:

UNIT I (12L)
Diode circuits and power Supplies: Junction diode characteristics - Half and full wave rectifiers - Expression for efficiency and ripple factor - Construction of low range power peak using diodes - Bridge rectifier - Filter circuits - Zener Diode - Characteristics - Regulated power supply using Zener diode - Clipper and Clamper using diodes. Differentiator and integrator using resistor and capacitor.
Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings, Applications;
UNIT II (8L)
Transistor circuits: Characteristics of a transistor in CB, CE modes - Relatively merits - Graphical analysis in CE configuration - Transistor as a amplifier - RC coupled Single stage amplifier - Frequency response - Thevenin's and Norton's theorems - h parameters.
Basis logic gates AND, OR, and NOT - Construction of basic logic gates using diodes and transistors.
UNIT III (12L) Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications.
Lasers: Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers.
UNIT IV (8L)
Quantum Physics Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, Born's interpretation of the wave function, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.

Learning Resources:
1. Principles of Electronics - V.K. Mehta, S. Chand & Co., 4/e, 2001.
2. Basic Electronics - B.L. Theraja, S. Chand & Co., 4/e, 2001.
3. Basic Electronics - B. Grob, McGraw - hill, 6/e, NY, 1989.
4. Elements of Electronics - Bagde & Singh, S. Chand & Co.

5. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker , Wiley
6. Optics, Hecht, Pearson Education
7. Optics, Ghatak, McGraw Hill Education India Private Limited
8. Principles of Lasers, O. Svelto, Springer Science & Business Media, 2010
9. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Robert Eisberg, Robert Resnick, Wiley.
10. Introduction to Quantum Mechanics, J. Griffiths David, Pearson Education

Practical

Subject Name: Basic Physics Lab	**Category: CC-7**
Subject Code: BSBINC392	**Semester: 3**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

BSBINC392.1: Apply the skill to impart practical knowledge in real time solutions.
BSBINC392.2: Demonstrate working principle, applications, measurement techniques and comparison of obtained results with theoretically calculated value.
BSBINC392.3: Apply concepts in the practical solution of practical.
BSBINC392.4: Apply measurement techniques, usage of new instruments and real time applications in Science and Technology.

Course Contents:

At least eight experiments are to be completed, preferably at least two from each type

At least eight experiments to be completed by each student taking at least two from each UNIT.
Experiments in Solid State Physics.
1. Characteristics of Zener diode

2. Characteristics of Thermistor
3. Fabrication of a regulated +5 v Power supply using 7805.
4. Zener diode as voltage regulator

Experiments in Optics :

1. Determination of resolving power of a prism.
2. Determination of dispersive power of the material of a prism.
3. Determination of wavelength of a monochromatic Laser light by Newton‘s ring
4. Determination of refractive index of a liquid by Newton‘s ring
5. Determination of wavelength of the given laser source by diffraction method
6. Determination of refractive index of a liquid by Newton‘s ring
7. Determination of Divergence and spot size of a Laser beam.

Experiments in Quantum Physics:

1. Determination of Planck constant using photocell.
2. Study of Photoelectric effect.
3. Franck – Hertz Experiment to study quantization of energy states in atom.
4. Abbes’ Experiment: to study the variation of refractive index with (a) temperature of the

b. Liquid sample (b) wavelength of the light source.

Subject Name: DATA Structure	**Category: CC-8**
Subject Code: BSBINC303	**Semester: 3**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes:

After completion of the course the students will be able to

Sl No	Course Outcome	Mapped Unit

1	BSBINC303.1: Recall the basics of data structure and describe the prerequisite of the data structure and algorithm.	I
2	BSBINC303.2: Demonstrate linear data structure, like linked list, stack and queue.	II
3	BSBINC303.3: Explain the knowledge of non-linear data structure, like graphs and trees.	III
4	BSBINC303.4: Apply different types of the searching and sorting algorithms.	IV

Course Contents:

UNIT I (8L)
Introduction to Data Structure
Introduction: Why do we need data structure? Linear and non-linear data structure. Algorithms: Introduction, basics of time and space analysis of algorithms.
Array: Concepts, 2D- dimensional array representation in memory. Recursion, String.
UNIT II (12L)
Linked list: Representation, Operation: traversing, searching, Insertion, deletion. Doubly linked list. Linked list representation of polynomial. Advantage of Linked List over Array.
Stack: representation (array & list), Application of Stack: prefix, infix & postfix, postfix to infix conversion & vice versa.
Queue: representation, Operations: Enqueue & Deques, Applications of Queue.
UNIT III (12L)
Graph theory: Concepts – Connected graph, regular graph, undirected graph, directed graph, complete graph, null graph, isomorphic graph, multi-graph and weighted graph. Hamiltonian cycle. Degree of vertex, in-degree & out-degree. Representation of graphs (adjacency matrix & list representation). Warshall's algorithm, shortest path algorithm. Application of graph theory in Biological Science. Tree, Binary Tree etc.
UNIT IV (8L)
Sorting Algorithms: Bubble, Selection, Insertion.
Searching Algorithms: Linear and Binary.

Learning Resources:
1. Fundamentals of Data Structures of C –by Ellis Horowitz, SartajSahni, Susan Andersonfreed.

2. Data Structures in C –by Aaron M. Tenenbaum.
3. Data Structures Using C –by ReemaThareja.
4. Introduction to Numerical Analysis – by Sahajahan Ali Mollah
5. Numerical Methods – by B.S. Grewal

Practical

Subject Name: Data Structure Lab	**Category: CC-8**
Subject Code: BSBINC393	**Semester: 3**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

BSBINC393.1: Apply appropriate logic and data structure to solve a given problem.
BSBINC393.2: Apply appropriate linear data structure to respective problems.
BSBINC393.3: Apply appropriate non-linear data structure related problems.
BSBINC393.4: Apply appropriate logic and data structure to solve searching and sorting problems.

Course Contents:

1. Write the programs to understand loop, function, structure etc.
2. Write the programs to understand recursion.
3. Write the programs to understand 1D and 2D array, string etc.
4. Write a program to perform stack operations using array.
5. Write a program to perform queue operations using array.
6. Write a program to perform link list operations (insertion, deletion, modification and searching).
7. Implement Tree data structure.

8. Implement Graph data structure.
9. Implement Bubble Sort algorithm in C to sort a list of integers.
10. Implement Selection Sort algorithm in C to sort a list of integers.
11. Implement Insertion Sort algorithm in C to sort a list of integers.
12. Implement a Linear Search algorithm to search an element in the list.
13. Implement Binary Search algorithm to search an element in the list.
14. Etc.

Learning Resources:

1. Fundamentals of Data Structures of C –by Ellis Horowitz, SartajSahni, Susan Andersonfreed.
2. Data Structures in C –by Aaron M. Tenenbaum.
3. Data Structures Using C –by ReemaThareja.
4. Introduction to Numerical Analysis – by Sahajahan Ali Mollah
5. Numerical Methods – by B.S. Grewal

Subject Name: Enzymology	**Category: SEC-1**
Subject Code: BSBINS301	**Semester: 3**
L-T-P: 2-0-0	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINS301.1: Demonstrate the process about the enzyme's purification and	I

	isolation.	
2	BSBINS301.2: Explain the classifications of enzymes and summarize the Enzyme substrate complex	II
3	BSBINS301.3: Estimate the mechanism of enzyme action.	III
4	BSBINS301.4: Outline the concept of Enzyme Technology.	IV

Course Contents:

UNIT I (10L)
Isolation, and purification of enzymes, Enzyme classification (rationale, overview and specific examples) Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH.

UNIT II (10L)
Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT III (10L)
Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes

UNIT IV (10L)
Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry.

Learning Resources:
1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.

3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

Subject Name: Industrial Fermentations	**Category: SEC-1**
Subject Code: BSBINS302	**Semester: 3**
L-T-P: 2-0-0	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINS302.1: Infer the basic concepts of industrial biochemical products, microbial polysaccharides and other types of biomolecules.	I
2	BSBINS302.2: Explain secondary metabolites, overproduction of metabolites, enzyme immobilization techniques.	II
3	BSBINS302.3: Distinguish different types of processing, fermentation processes and product recovery methods.	III
4	BSBINS302.4: Estimate the reaction enzyme kinetics and metabolic engineering of biosynthetic pathways	IV

Course Contents:

UNIT I (7L)

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavors and fragrances, newer antibiotics, anti-cancer agents, amino acids.

UNIT II (12L)

Microbial products of pharmacological interest, steriod fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT III (11L)

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, Ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT IV (10L)

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up.Metabolic engineering of antibiotic biosynthetic pathways.

Learning Resource:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology.

Subject Name: Molecular Biology	**Category: SEC-1**
Subject Code: BSBINS303	**Semester: 3**
L-T-P: 2-0-0	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINS303.1: Identify the strong foundation on DNA structure and replication machineries.	I
2	BSBINS303.2: Describe the sources and mechanism of DNA damage and repair.	II
3	BSBINS303.3: Demonstrate the process of transcription and RNA processing.	III
4	BSBINS303.4: Discuss on regulation of gene expression and protein synthesis	IV
5	BSBINS303.5: Explain the basics of gene cloning technique and associated enzymes and vectors.	V

Course Contents:

UNIT I (8L)
DNA structure and replication.
DNA as genetic material, structure of DNA, Types of DNA, Replication of DNA in prokaryotes and Eukaryotes, Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.
UNIT II (8L)
DNA damage, repair, nonhomologous and homologous recombination.
DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photo- reactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination:models and mechanism.

UNIT III (10L)

Transcription and RNA processing.

RNA structure and types of RNA, Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters,enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV (8L)

Regulation of gene expression and translation.

Regulation of gene expression in prokaryotes: Operon concept (inducible and system), Genetic code and its characteristics, Prokaryotic and eukaryotic eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation., Posttranslational modifications of proteins.

UNIT V (6L)

How to clone a gene.

What is clone, overview of the procedure, Gene library, hybridization Cutting and Joining DNA- Restriction Endonucleases, Ligation, Alkaline phosphate, Modification of Restriction fragment ends, Other ways of joining DNA molecules. Plasmid vectors, Vectors based on the lambda bacteriophage, cosmids, M13 vectors, Expression vectors, Vectors for cloning and expression in Eukaryotic cells, Super vectors- YACs and BACs

Learning Resources:

1. Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition,Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.

Subject Name: Basics of Bioinformatics and Methods	**Category: CC-9**
Subject Code: BSBINC401	**Semester: 4**

L-T-P: 4-0-0	Credit: 4

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINC401.1: Describe the basic concept of Bioinformatics.	I
2	BSBINC401.2: Classify the different types of Biological Database.	II
3	BSBINC401.3: Recognize different types of biological data storage, retrieval, and interoperability techniques.	III
4	BSBINC401.4: Demonstrate the sequence analysis, gene expression techniques, and representation of their patterns.	IV, V
5	BSBINC401.5: Use the concept of molecular modeling and protein design.	VI, VII

Course Contents:

UNIT I (5L)
Introduction to bioinformatics and data generation
What is bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer).
Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.

UNIT II (5L)
Biological Database and its Types
Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data

sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum)

UNIT III (5L)

Data storage and retrieval and Interoperability

Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt). Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search. The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts.

UNIT IV (8L)

Sequence Alignments and Visualization

Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm). Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization.

UNIT V (7L)

Gene Expression and Representation of patterns and relationship

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

UNIT VI (5L)

Concept of molecular modeling, in silico methods of molecular modelling, software for homology modeling, computer and graphic representation of simple molecules and peptides, use of structural databases in molecular modelling.

UNIT VII (5L)

Concepts of geometry optimization and energy minimization, introduction of molecular dynamic simulation and monte carlo simulation, concepts and applications of macromolecular docking.

Learning Resources:

1. Andreas D. Bazavanis and B.F. Francis (Eds.) Bioinformatics: A Practical Guide to Analysis of Genes and Proteins, Wiley Interscience Publishers.
2. Thomas Lengauer (Eds.) Bioinformatics – Genomes to Drugs, Vol. I: Basic Technologies, Wiley-WCH publishers.

3. Jay A. Glasel and Murray P. Deutscher (Eds.) Introduction to Biophysical Methods for Protein and Nucleic Acid Research, Academic Press.
4. T.K. Attwood and DJ Parry Smith Introduction to Bioinformatics, Pearson education, Asia.

Practical

Subject Name: Basics of Bioinformatics and Methods LAB	**Category: CC-9**
Subject Code: BSBINC491	**Semester: 4**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

BSBINC491.1: Apply different types of biological databases.
BSBINC491.2: Apply different types of tools for sequence comparison, gene finding, phylogenetic analysis.
BSBINC491.3: Apply different tools to analyze protein structure

Course Contents:

1. Biological databases: NCBI, EMBL, DDBJ, iHOP, PDB, UniProt, KEGG, Ensembl, STRING;
2. Sequence file formats: GenBank, FASTA, EMBL, PDB format
3. DotPlot Analysis: DOTPLOT, DOTTER, DOTMATCHER,
4. Pairwise Sequence Alignment programs: LALIGN, EMBOSS NEEDLE, EMBOSS Water
5. Multiple Sequence Alignment programs: Clustalw, Muscle, T-Coffee
6. Similarity Searching: BLAST, Variants of Blast
7. Phylogenetic analysis software: MEGA, PHYLIP
8. Gene Identification Programs: GENSCAN, ORF finder, Fgenesh, Glimmer
9. Primer Designing: PRIMER3

10. Protein Identification and characterization: Protparam, Peptide cutter, Motif and Patterns program: Prosite, InterProScan, Pfam
11. 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol)
12. Modelling software: Swiss Model workspace, ArgusLab, Model Evaluation: PRocheck. Docking-Hex

Learning Resources:

1. Andreas D. Bazavanis and B.F. Francis (Eds.) Bioinformatics: A Practical Guide to Analysis of Genes and Proteins, Wiley Interscience Publishers.
2. Thomas Lengauer (Eds.) Bioinformatics – Genomes to Drugs, Vol. I: Basic Technologies, Wiley-WCH publishers.
3. Jay A. Glasel and Murray P. Deutscher (Eds.) Introduction to Biophysical Methods for Protein and Nucleic Acid Research, Academic Press.
4. T.K. Attwood and DJ Parry Smith Introduction to Bioinformatics, Pearson education, Asia.

Subject Name: Bioanalytical Tools	**Category: CC-10**
Subject Code: BSBINC402	**Semester: 4**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINC402.1: Explain the functioning, maintenance and safety aspects of the basic apparatus used in a Biotechnology lab.	I
2	BSBINC402.2: Explain the principles and applications of centrifuge, electrophoresis and chromatography in research and related experiments	II

3	BSBINC402.3: Apply the knowledge for the separation of proteins/peptides by selecting appropriate separation techniques.	III, IV
4	BSBINC402.4: Classify certain functionalities of biomolecules by using spectroscopic techniques.	V

Course Contents:

UNIT I (5L)
Important features and applications of autoclave, incubators and shakers; Bio-safety cabinets (vertical and horizontal); growth chambers (BOD and CO2 chambers); pH meter (calibration, operation and maintenance).

UNIT II (5L)
Basic principle of sedimentation; Centrifugation and their types; Care and maintenance of centrifuges; preparative centrifugation and its applications: differential centrifugation, density gradient centrifugation.

UNIT III (10L)
Basic principles of electrophoresis, electrophoresis of DNA: Agarose gels, polyacrylamide gels, native (buffer) gels, gradient gels; electrophoresis of proteins; SDS-PAGE, isoelectric focusing gel electrophoresis; detection, quantification and recovery of proteins in gels.

UNIT IV (10L)
Basic principle of chromatography; distribution coefficients; components of chromatography; chromatographic performance parameters; modes of chromatography; different types of chromatography and their applications: thin layer chromatography (TLC), basic column chromatography, gel-permeation chromatography, ion exchange and affinity chromatography.

UNIT V (5L)
Properties of electromagnetic radiation, interaction with matter; atomic absorption and emission spectroscopy; principles and applications of UV-VIS spectroscopy, instrumentation, atomic absorption spectroscopy and spectrofluorimetry (principles, instrument and application); Infrared spectroscopy (principles, instrument and application).

Learning Resources:

1. Principles and Techniques of Biochemistry and molecular Biology, Edited by Keith Wilson & John Walker, Cambridge Publication, 6th Edition
2. Biophysical Chemistry; applications to Biochemistry and Molecular Biology, By David Freifelder, 1982
3. Principles of Fermentation Technology, 2nd ed., Oxford/ N.Y.: Pergamon, 1995
4. Spectrophotometric identification of organic compounds, Robert M. Silverstein and Francis X. Webstar, John Willey and sons, Canada Ltd 1997 Principles and Practice of Bioanalysis by Richard F. Venn

Practical

Subject Name: Bioanalytical Tools Lab	**Category: CC-10**
Subject Code: BSBINC492	**Semester: 4**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

BSBINC492.1: Demonstrate basic apparatus used in a Biotechnology lab.
BSBINC492.2: Apply different types of centrifuge, electrophoresis and chromatography techniques.
BSBINC492.3: Apply the knowledge for identification of different biomolecules by using spectroscopic techniques.

Course Contents:

1. Use and maintenance of autoclave, incubators and shakers; Bio-safety cabinets; growth chambers; pH meter
2. Use and maintenance of different types of Centrifugation.
3. Perform electrophoresis: Agarose Gel, PAGE
4. Application of Chromatographic techniques: TLC, column chromatography
5. Use and maintenance of spectrophotometer: UV-VIS

Learning Resources:

1. Principles and Techniques of Biochemistry and molecular Biology, Edited by Keith Wilson & John Walker, Cambridge Publication, 6th Edition
2. Biophysical Chemistry; applications to Biochemistry and Molecular Biology, By David Freifelder, 1982
3. Principles of Fermentation Technology, 2nd ed., Oxford/ N.Y.: Pergamon, 1995
4. Spectrophotometric identification of organic compounds, Robert M. Silverstein and Francis X. Webstar, John Willey and sons, Canada Ltd 1997 Principles and Practice of Bioanalysis by Richard F. Venn

Subject Name: Molecular Diagnostics	**Category: SEC-2**
Subject Code: BSBINS401	**Semester: 4**
L-T-P: 2-0-0	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINS401.1: Summarize the basic idea of enzyme immunoassays.	I
2	BSBINS401.2: Describe the molecular methods used in clinical microbiology.	II
3	BSBINS401.3: Apply portable devices and assays & kits used for detect and diagnose diseases in human samples.	III
4	BSBINS401.4: Demonstrate searching data, information, methodologies in order to set up and validate new diagnostic protocols.	IV

Course Contents:

UNIT I (12L)
Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immunohistochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

UNIT II (10 L)
Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests (Lab – Demonstration of RAPD, Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture)

UNIT III (10 L)
Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT IV (8 L)
GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.

Learning Resources:
1. Principles and Techniques of Biochemistry and molecular Biology, Edited by Keith Wilson & John Walker, Cambridge Publication, 6th Edition
2. Biophysical Chemistry; applications to Biochemistry and Molecular Biology, By David Freifelder, 1982

Subject Name: Basics of Forensic Science	**Category: SEC-2**
Subject Code: BSBINS402	**Semester: 4**
L-T-P: 2-0-0	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINS402.1: Describe the basic concepts of forensic science and laboratories and can classify the injuries and various types of deaths	I
2	BSBINS402.2: Classify the arms and explosive and compare handwriting	II
3	BSBINS402.3: Describe the role of toxicologists and applications of fingerprinting	III
4	BSBINS402.4: Outline the concept of DNA fingerprinting and cyber security	IV

Course Contents:

UNIT I (10L)
Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

UNIT II (10L)
Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink (various samples).

UNIT III (10L)
Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification.

UNIT IV (10L)
Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, e-Discovery, Evidence Preservation,

Search and Seizure of Computers, Introduction to Cyber security.

Learning Resources:

1. Forensic Science: The Basics, by Jay A Siegel, Kathy Mirakovits
2. Principles and Techniques of Biochemistry and molecular Biology, Edited by Keith Wilson & John Walker, Cambridge Publication, 6th Edition
3. Biophysical Chemistry; applications to Biochemistry and Molecular Biology, By David Freifelder, 1982

Subject Name: Research methodology	**Category: SEC-2**
Subject Code: BSBINS403	**Semester: 4**
L-T-P: 2-0-0	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINS403.1: Choose research problem formulation.	I, II
2	BSBINS403.2: Analyze research related information	III
3	BSBINS403.3: Recognize research ethics.	IV

Course Contents:

UNIT I (10L)
Foundations of Research Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied

UNIT II (12L)

Research Design Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

UNIT III (12L)

Data Collection, Analysis and Report Writing

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

UNIT IV (6L)

Ethical Issues Concepts of Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

Learning Resources:

1. Research Methodology : Methods And Techniques by C.R. Kothari and Gaurav Garg

Subject Name: Structural Bioinformatics	**Category: CC-11**
Subject Code: BSBINC501	**Semester: 5**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBINC501.1: Outline the basic concept of biomolecular structure.	I

2	BSBINC501.2: Illustrate the concepts of protein structure and its mechanism of folding.	II, III
3	BSBINC501.3: Summarize the RNA structure prediction methods.	IV
4	BSBINC501.4: Discuss the importance of Drug design & discovery.	V

Course Contents:

UNIT I (8L)
Macromolecular Structures: DNA: Types of Double helices (A,B,Z).RNA: Secondary structures, Tertiary structures. Amino acid: Structure and Properties of Amino acids, Structure of proteins: Hierarchical organization of protein structure- Primary, Secondary, Supersecondary, Tertiary, Quaternary structure. Ramachandran Plot and its importance
UNIT II (8L)
Protein folding: Principle of Protein folding & Unfolding: Levinthal Paradox, Anfinsen's experiment, thermodynamics of protein folding, Protein misfolding, Disorders/Diseases of Protein Misfolding (Alzheimer's disease, Cystic fibrosis, Mad Cow disease, Prions). Protein – protein interaction and protein DNA interaction, methods and significance. Identification of salt-bridge of proteins and explanation of its function.
UNIT III (8L)
Protein Structure: Classifying protein structure and sequence-Active site of protein, protein architecture, blocks, classes, protein core, protein domain, Protein family, Protein fold, profiling of protein sequence, super family of protein, Classes of protein structure
UNIT IV (8L)
Structure Prediction & Comparison : RNA secondary structure prediction methods and its application (mfold method of Zuker), Methods for protein secondary and tertiary structure prediction-Algorithms of Chou Fasman, GOR, PSI-PRED and Artificial Neural network,Steps involved in Homology Modeling, Concepts in 3D structure comparison
UNIT V (8L)
Drug design & discovery : Definition of drugs, steps in development of new drugs, chemical & physiochemical parameters in drug-designing, drug metabolism, Interaction energy calculations, structure based drug designing, Combinatorial chemistry, virtual & high throughput screening, Docking and its importance, Introduction to energy minimization and Molecular Dynamics.

Learning Resources:

1. Liebler, D. 2002 Introduction to Proteomics: Tools for New Biology. Human Press Totowa.
2. Campbell, A.M. &Heyer, L.J. 2002 Discovering Genomics, Proteomics and Bioinformatics. Benjamin/Cummings.
3. Structural Bioinformatics by Philip E. Bourne and Helge Weissing, Wiley.
4. Introduction to Protein structure by Brandel C. and Tooze, J.
5. Structure and Mechanism in Protein science – Fersht WH freeman & Co 6. Protein folding – Creighton TE (ed) WH Freeman & Co.
7. Structural Bioinformatics by Philip E. Bourne and Helge Weissing, Wiley

Practical

Subject Name: Structural Bioinformatics Lab	**Category: CC-11**
Subject Code: BSBINC591	**Semester: 5**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

BSBINC591.1: Explain and apply the modelling technique of protein.
BSBINC591.2: Estimate the energy of the protein and predicting the salt bridge interactions in protein.
BSBINC591.3: Experiment with energy minimization of protein and Molecular docking study of protein-ligand complex.
BSBINC591.4: Identify the major and minor groove in DNA.
BSBINC591.5: Examine different structures of nucleic acids.

Course Contents:

1. Building the Loop region of protein.
2. Scanning the Loop data Base
3. Braking and ligate the backbone of protein
4. Adding the missing residues of disorder region of protein
5. Adding H-atoms and water molecules in the protein.
6. Compute the H-bonds and molecular surface in the protein

7. Calculation of potential energy of the protein.
8. Investigation of salt-bridge in protein structures
9. Energy minimization of the protein, water, and water –protein complex.
10. Modify the Phi, Psi angles of protein
11. Identification of protein domain from Uniport database
12. Molecular docking study of protein-ligand complex.
13. Analyze and display the base pairs of nucleic acids
14. H-bonding analysis of different base pairs in DNA.
15. Identification of major and minor groove in DNA.
16. Structure presentation of double helical model of DNA structure and A, B & Z – DNA.

Learning Resources:

1. Liebler, D. 2002 Introduction to Proteomics: Tools for New Biology. Human Press Totowa.
2. Campbell, A.M. &Heyer, L.J. 2002 Discovering Genomics, Proteomics and Bioinformatics. Benjamin/Cummings.
3. Structural Bioinformatics by Philip E. Bourne and Helge Weissing, Wiley.
4. Introduction to Protein structure by Brandel C. and Tooze, J.
5. Structure and Mechanism in Protein science – Fersht WH freeman & Co 6. Protein folding – Creighton TE (ed) WH Freeman & Co.
7. Structural Bioinformatics by Philip E. Bourne and Helge Weissing, Wiley

Subject Name: Programming in Python	**Category: CC-12**
Subject Code: BSBINC502	**Semester: 5**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit

1	BSBINC502.1: Describe the basic concepts of python installation, programming syntax, and debugging.	UNIT I
2	BSBINC502.2: Illustrate several types of operators and control structures used in programming.	UNIT II
3	BSBINC502.3: Apply the concepts of String operation, File and Function.	UNIT III
4	BSBINC502.4: Illustrate the concepts of List, Dictionaries and Tuples.	UNIT IV

Course Contents:

UNIT I (5L)

Introduction to Python, installation of Python, character set, Constants, variables and keywords. Type of variables & constants. Rules of constructing variable identifiers.

UNIT II (10L)

Types of C Instructions (Type declaration, Arithmetic & Control Instructions), Data Types, Operators, Keywords, Hierarchy of operators, Associativity of operators, Type conversion (explicit and implicit), Different types of operators, Control Instructions: if-else, switch case, conditional operator. Loops (for, while), break & continue statement.

UNIT III (10L)

String operations- Asking the user for input, Comments, String slices, String length, Strings are immutable, in operator, String comparison, String methods, Parsing strings, Format operator,

Function calls- Built-in functions, Type conversion functions, Math functions, adding new functions, Function Definitions and uses, Flow of execution, Parameters and arguments, Fruitful functions and void functions,

Files- Persistence, opening files, Text files and lines, reading files, searching through a file, User choose the file name, using try-except-open, Writing files.

UNIT IV (15L)

Lists- list is a sequence, Lists are mutable, traversing a list, List operations, List slices, List methods, deleting elements, Lists and functions, Lists and strings, Objects and values, List arguments.

Dictionaries- Dictionary as a set of counters, Dictionaries and files, Looping and dictionaries.

Tuples- Tuples are immutable, comparing tuples, Tuple assignment, Dictionaries and tuples, Multiple assignment with dictionaries, Using tuples as keys in dictionaries.

Learning Resources:

1. Introduction to Python Programming language- Chaitanya Singh
2. Python programming language- by G van Rossum
3. Python Programming: An Introduction to Computer Science, by John Zelle.

Practical

Subject Name: Programming in Python Lab	**Category: CC-12**
Subject Code: BSBINC592	**Semester: 5**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

BSBINC592.1: Apply the basic syntax of python to solve problems.
BSBINC592.2: Apply several types of operators and control structures to solve given problems.
BSBINC592.3: Apply the concepts of String operation, File and Function.
BSBINC592.4: Apply the concepts of List, Dictionaries and Tuples.

Course Contents:

1. Write a program that uses input to prompt a user for their name and then welcomes them.
2. Write a program to prompt the user for hours and rate per hour to compute gross pay.
3. Write a program which prompts the user for a Celsius temperature, convert the temperature to Fahrenheit, and print out the converted

temperature.

4. Write a program to prompt for a score between 0.0 and 1.0. If the score is out of range, print an error message. If the score is between 0.0 and 1.0, print a grade using the following-

Score	**Grade**
>= 0.9	A
>= 0.8	B
>= 0.7	C
>= 0.6	D
< 0.6	F

5. Write a program for pay computation with time-and-a-half for overtime and create a function called compute_pay which takes two parameters (hours and rate).

6. Write a program for the grade program (program 4) using a function called compute_grade that takes a score as its parameter and returns a grade as a string.

7. Write a program to find factorial of given positive integer using function.

8. Write a menu driven program which has following options using function:

a. Factorial of a number. b. Prime or not. c. Odd or even. d. Exit.

9. Write a program which repeatedly reads numbers until the user enters "done". Once "done" is entered, print out the total, count, and average of the numbers. If the user enters anything other than a number, detect their mistake using try and except and print an error message and skip to the next number.

10. Write another program that prompts for a list of numbers as above and at the end prints out both the maximum and minimum of the numbers instead of the average.

11. Write a program to check whether given string is palindrome or not.

12. Write a program to read through a file and print the contents of the file (line by line) all in upper case.

13. Write a program to prompt for a file name, and then read through the file and copy the content to another file.

14. Write a program to open the file and read it line by line. For each line, split the line into a list of words using the split function. For each word, check to see if the word is already in a list. If the word is not in the list, add it to the list. When the program completes, sort and print the resulting words in alphabetical order.

15. Write a program to read a file and when you find line that starts with "From", you will split the line into words using the split function.

Print each line from the second word on the “From” line.

16. Write a program that prompts the user for a list of numbers and prints out the maximum and minimum of the numbers at the end when the user enters "done". Write the program to store the numbers the user enters in a list and use the max() and min() functions to compute the maximum and minimum numbers after the loop completes.

17. This program counts the distribution of the hour of the day for each of the messages (for a file stored relevant information). You can pull the hour from the "From" line by finding the time string and then splitting that string into parts using the colon character. Once you have accumulated the counts for each hour, print out the counts, one per line, sorted by hour.

18. Etc.

Learning Resources:

4. Introduction to Python Programming language- Chaitanya Singh
5. Python programming language- by G van Rossum
6. Python Programming: An Introduction to Computer Science, by John Zelle.

Subject Name: Biostatistics	**Category: DSE-1**
Subject Code: BSBIND501(A)	**Semester: 5**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBIND501(A).1: Distinguish different statistical data collection and graphical representation techniques	I
2	BSBIND501(A).2: Describe the application of probability and different types of	II

	distribution.	
3	BSBIND501(A).3: Apply the concepts of hypothesis testing	III
4	BSBIND501(A).4: Analyze correlation and regression on biological data	IV

Course Contents:

UNIT I (12 L)
Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.
UNIT II (18 L)
Probability classical & axiomatic definition of probability, Theorems on total and compound probability, Elementary ideas of Binomial, Poisson and Normal distributions.
UNIT III (18 L)
Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)
UNIT IV (12 L)
Correlation and Regression. Emphasis on examples from Biological Sciences.

Learning Resources:
1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

Subject Name: Plant Biotechnology	**Category: DSE-1**

Subject Code: BSBIND501(B)	**Semester: 5**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBIND501(B).1: Discuss about plant tissue culture applications.	I
2	BSBIND501(B).2: Explain the basics of *in vitro* haploid production Androgenic methods.	II
3	BSBIND501(B).3: Demonstrate the applications of plant genetic engineering.	III
4	BSBIND501(B).4: Apply different experimental methods in plant biotechnology.	IV

Course Contents:

UNIT I (15L)

Plant Tissue Culture applications – Introduction, organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell. Micropopagation of Axillary bud proliferation, Meristem and shoot tip culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT II (15L)

In vitro haploid production Androgenic methods: Anther culture, Microspore culture Andogenesis, Double haploid production Significance and use of double haploids, Gynogenic haploids, factors effecting gynogenesis.

UNIT III (15L)

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of

hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation.

UNIT IV (15L)

Applications of Plant Genetic Engineering – crop improvement, herbicide resistance,insect resistance, virus resistance, plants as bioreactors. Genetic modification in Agriculture – transgenic plants, genetically modified foods,application, future applications, ecological impact of transgenic plants.

Learning Resources:

1. Plant Biotechnology**,** by Singh B.D.
2. Introduction To Plant Biotechnology by Chawla H S

Subject Name: Medical Biotechnology	**Category: DSE-1**
Subject Code: BSBIND501(C)	**Semester: 5**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBIND501(C).1: Describe the basics of gene therapy	1
2	BSBIND501(C).2: Explain the development of Vaccine and Synthetic therapy	2
3	BSBIND501(C).3: Apply tissue engineering method	3
4	BSBIND501(C).4: Show the processes of drug delivery	4

Course Contents:

UNIT I (15L)
Gene therapy – background, types of gene therapy (ex vivo & in vivo), choosing targets for gene therapy, vectors in gene therapy, retroviruses, adenoviruses, adeno-associated viruses, types of gene delivery, Weismann barrier (soma-to-germ line barrier), epigenetic inheritance, problems & ethics.
Gene Delivery methods – Viral delivery (through Retroviral vectors, through Adenoviral vectors), Non- viral delivery, Antibody engineering.
Gene therapy Models – Liver diseases, Lung diseases, Hematopoietic diseases, Circulated gene products, Cancer & Auto-immune diseases.

UNIT II (15L)
Vaccines – Vaccine vectors, nucleic acid vaccines, immuno-enhancing technology.
Synthetic therapy – synthetic DNAs, therapeutic Ribozymes, synthetic drugs.

UNIT III (15L)
Tissue Engineering – Skin, Liver, Pancreas.
Xenotransplantation – terminology, technology behind it, organ donors, social &ethical issues.
Cell Adhesion-based therapy – integrins, inflammation, cancer & metastasis.

UNIT IV (15L)
Drug delivery – conventional & new approaches to drug delivery.

Learning Resources:

1. Medical Biotechnology (Oxford Handbooks), by P. Nallari and V.V. Rao
2. Medical Biotechnology: Principles and Applications of Recombinant DNA (ASM Books), by Bernard R. Glick , Cheryl L. Patten , et al.

Subject Name: Linux & Shell Scripts	**Category: DSE-2**
Subject Code: BSBIND502(A)	**Semester: 5**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes:

After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBIND502(A).1: Distinguish different types of Linux distribution and desktop environment.	I
2	BSBIND502(A).2: Use the terminals and shell	II
3	BSBIND502(A).3: Describe how to use directories and different types of files	III
4	BSBIND502(A).4: Apply different commands used in Linux	IV
5	BSBIND502(A).5: Apply different types of editors in Linux	V
6	BSBIND502(A).6: Show the use of conditional checking, looping, regular expression searching in shell scripting.	VI

Course Contents:

UNIT I (8L)
Introduction to linux and its distribution; Linux kernel; Filesystems; GNU/Linux Shells; Linux desktop environment (GNOME)

UNIT II (6L)
CLI in Shell; Terminals: Console, Graphical; Graphical Terminal Emulator Packages; Different menus and keyboard shortcuts in GNOME; Interact with the shell; Bash manual

UNIT III (10L)
Linux directories and their usage; Traversing directories; Listing Files and Directories; Filtering listing output; Handling Files: creating, copying, moving/renaming, deleting; Managing Directories: creating, deleting; Viewing Files: full, parts (head and tail);

UNIT IV (10L)
Useful Linux commands: ps, kill, mount, umount, df; Sorting data; Searching for data (grep); compressing data (gzip, tar); Setting the PATH Environment Variable; Use of file permission symbols; Install, uninstall and upgrade software; Installing package from Source Code

UNIT V (2L)
Working with editors: VIM; Copying and pasting; Searching and substituting; Basics of gedit

UNIT VI (4L)
Creating script file; variables; Redirecting Input and Output; use of pipes; Basic mathematical operations; if-then-else Statement; loops; Getting User Input; Running Scripts in Background Mode; Regular expression

Learning Resources:
1. Linux Command Line and Shell Scripting Bible. Richard Blum and Christine Bresnahan. Wiley; ISBN 111898384X
2. The Linux Command Line, 2nd Edition: A Complete Introduction; William Shotts. ISBN 1593279523
3. Wicked Cool Shell Scripts, 2nd Edition: 101 Scripts for Linux, OS X, and UNIX Systems. Dave Taylor. No Starch Press; ISBN 1593276028

Practical

Subject Name: Linux & Shell Scripts LAB	**Category: DSE-2**
Subject Code: BSBIND502(A)	**Semester: 5**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes:

After completion of the course the students will be able to:

BSBIND502(A).1: Apply linux terminal to run different commands.
BSBIND502(A).2: Apply the concept of file handling and directories.
BSBIND502(A).3: Apply text editor in linux environment.
CO3: Demonstrate how different patterns can be searched using regular expression.

Course Contents:

1. Working with Linux terminal.
2. Working with directories: Listing files, filtering files.
3. File handling and managing directories
4. Different useful Linux commands and their utilities
5. Working with VIM editor
6. Write shell scripts; File input, output; if-then-else; loops
7. Application of regular expression in bioinformatics

Learning Resources:

4. Linux Command Line and Shell Scripting Bible. Richard Blum and Christine Bresnahan. Wiley; ISBN 111898384X
5. The Linux Command Line, 2nd Edition: A Complete Introduction; William Shotts. ISBN 1593279523
6. Wicked Cool Shell Scripts, 2nd Edition: 101 Scripts for Linux, OS X, and UNIX Systems. Dave Taylor. No Starch Press; ISBN 1593276028

Subject Name: Genomes to drug and vaccine	**Category: DSE-2**
Subject Code: BSBIND502(B)	**Semester: 5**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBIND502(B).1: Summarize basic knowledge about the genome database and gene identification.	I, II
2	BSBIND502(B).2: Demonstrate the computational drug discovery process.	III

3	BSBIND502(B).3: Show the importance of immunoinformatics.	IV
4	BSBIND502(B).4: Explain about different types of vaccine.	V

Course Contents:

UNIT I (12L)

Genome Assembly, Genome Databases and related data resources (EST, STS, GSS, HSS etc.), Nature and types of data, Organization of data in databases, Genome Data, Tools for Genomic Data Mining.

UNIT II (12L)

Basic Aspects of Genome Annotation, Database Search Engines: Special tools for searching genomic data, Prediction of ORFs and Genes, Identification of Disease Genes in the context of Human Genetics and Genetics of Model Animals.

UNIT III (12L)

Identification of Drug Targets, Pharmacogenetics, The genetics of drug metabolism, the genetics of therapeutic targets; Interactions of small molecules and gene-based drug targets.

UNIT IV (12L)

Protein Sequence Analysis and Prediction of epitomes on Genomic scale Interactions of epitomes with Antibodies, MHC molecules and TCR.

UNIT V (12L)

Approaches for designing vaccines, Peptide/DNA vaccines, Polytope vaccines, Recombinant vaccines.

Learning Resources:

1. Bioinformatics from Genome to drugs (ed.) Vol., I &II ; Thomas Lengaure
2. Microcomputer in physiology : a practical approach ; P.J. Frasre

Subject Name: Seminar on Emerging Area of Bioinformatics	**Category: SEC-3**
Subject Code: BSBINS501	**Semester: 5**
L-T-P: 2-0-0	**Credit: 2**

Course Outcomes: After completion of the course the students will be able to:

BSBINS501.1: Write, discuss and present about emerging biology-related topics individually or in groups.
BSBINS501.2: Able to connect and integrate the knowledge of bioinformatics with microbiology and immunology.
BSBINS501.3: Develop the knowledge about recent techniques in bioinformatics.

Course Contents:

Students have to perform one project and one seminar in the semester any one of the following:
• Seminars on Applications of Bioinformatics in Biotechnology
• Seminars on Applications of Bioinformatics in Drug Designing
• Seminars on Applications of Bioinformatics in Agriculture
• Seminars on Applications of Bioinformatics in Human Health
• Seminars on Applications of Bioinformatics in Plant Breeding
• Seminars on Applications of Bioinformatics in Veterinary science
• Seminars on Applications of Bioinformatics in any recent field of science.

Subject Name: IMMUNOLOGY	**Category: CC-13**
Subject Code: BSBINC601	**Semester: 6**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
01	BSBINC601.1: Describe the history and concepts of immunology.	I
02	BSBINC601.2: Distinguish Antigens, antibodies and Major Histocompatibility	II

	Complex.	
03	BSBINC601.3: Describe Complement System and Generation of Immune Response.	III
04	BSBINC601.4: Show the application of different Immunological Techniques, Vaccines & Vaccination.	IV

Course Contents:

UNIT I (15L)

Introduction Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

Immune Cells and Organs Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

UNIT II (15L)

Antigens Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

Antibodies Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); Monoclonal and Chimeric antibodies

Major Histocompatibility Complex Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

UNIT III (15L)

Complement System Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Generation of Immune Response Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

Immunological Disorders and Tumor Immunity Types of AutoimmUNITy and Hypersensitivity with examples; Immunodeficiencies –

Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens and cancer.

UNIT IV (15L)

Immunological Techniques Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

Vaccines & Vaccination adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, tumor vaccines, principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs.

Learning Resources:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Practical

Subject Name: Immunology Lab	**Category: CC-13**
Subject Code: BSBINC691	**Semester: 6**
L-T-P: 0-0-4	**Credit: 2**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

Course Outcomes: After completion of the course the students will be able to:

BSBINC691.1: Identify human blood groups, Leukocyte Count etc.

BSBINC691.2: Implement immunodiffusion and Immunoelectrophoresis.
BSBINC691.3: Experiment with antibody and antigen.

Course Contents:

Practicals:

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum from the blood sample (demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Immunoelectrophoresis
7. Antigen- antibody reaction (Coomb's test)
8. ELISA.
9. antibody and antigen (Ouchterlony method)
10. ELISA.

Learning Resources:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Subject Name: Data Analysis with R	**Category: CC-14**
Subject Code: BSBINC602	**Semester: 6**
L-T-P: 4-0-0	**Credit: 4**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
01	BSBINC602.1: Describe the basic concepts of R programming.	I
02	BSBINC602.2: Understand and apply several operators, types and control structures used in programming.	II
03	BSBINC602.3: Describe and apply the concepts of list, matrices, loop, functions etc.	III
04	BSBINC602.4: Apply the programming to solve statistical problems and visualize the results.	IV

Course Contents:

UNIT I (10L)
Construct and execute basic programs in R using elementary programming techniques, e.g. import/export of data from file or Internet, assign and manipulate data structures, create user-defined functions, loops, condition statements and debugging.
UNIT II (10L)
Use R for statistical calculations
UNIT III (10L)
Graphically visualise data and results of statistical calculations
UNIT IV (10L)
Use external R-packages in statistics and data mining

Learning Resources:
1. Data Analysis with R: A comprehensive guide to manipulating, analyzing, and visualizing data in R, 2nd Edition, by Anthony Fischetti
2. Data Analysis Using R: A Primer for Data Scientist, by Dr. Dhaval Maheta
3. Hands-On Exploratory Data Analysis with R: Become an expert in exploratory data analysis using R packages, by Radhika Datar and Harish Garg

Maulana Abul Kalam Azad University of Technology, West Bengal
B.Sc. in Bioinformatics Program: 2021-2022

Practical

Subject Name: Data Analysis with R LAB	**Category: CC-14**
Subject Code: BSBINC692	**Semester: 6**
L-T-P: 0-0-4	**Credit: 2**

Course Outcomes: After completion of the course the students will be able to:

BSBINC692.1: Apply basic syntax of R language to solve simple problems.
BSBINC692.2: Apply R language syntax to solve operators, data types and control structures related problems.
BSBINC692.3: Apply R language syntax to solve list, matrices, function related problems.
BSBINC692.4: Apply R language syntax to solve statistical problems and File concept related problems.

Course Contents:

1. Installation R and RStudio and get familiar with the RStudio interface
2. Understand R data types
3. Understand R data structures, in particular vectors and data frames
4. Matrices and Factors in R
5. If Else and Nested If Else in R
6. Loops with R
7. Understand R functions
8. Understand R Markdown and the process for submitting assignments
9. Handle external tabular data from a .csv file
10. Extract values from vectors and data frames.
11. Perform operations on columns in a data frame.
12. Append columns to a data frame.
13. Create subsets of a data frame.
14. Exploratory Data Analysis - Create simple scatterplots, histograms, and boxplots in R, ggplot2 package.
15. Elementary Statistics with R

Passed in Board of Studies Meeting on Approved in Academic Council Meeting on

16. Gene Expression data analysis
17. Examples of packages in R

Learning Resources:

1. Data Analysis with R: A comprehensive guide to manipulating, analyzing, and visualizing data in R, 2nd Edition, by Anthony Fischetti
2. Data Analysis Using R: A Primer for Data Scientist, by Dr. Dhaval Maheta
3. Hands-On Exploratory Data Analysis with R: Become an expert in exploratory data analysis using R packages, by Radhika Datar and Harish Garg

Subject Name: IPR, Biosafety and Ethical Issues	**Category: DSE-3**
Subject Code: BSBIND601(A)	**Semester: 6**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
01	BSBIND601(A).1: Identify the importance of IPR, Good laboratory practices.	I
02	BSBIND601(A).2: Demonstrate the concept of intellectual property rights, patenting organisms and process of filing for a patent.	II
03	BSBIND601(A).3: Describe the issues and bioethics related to molecular technologies and GMOs.	III, IV, V

Course Contents:

UNIT I (12L)
Introduction to Intellectual property Rights- Concept of IPR, different forms of IPR

UNIT II (12L)
Classification of patents, Special patents, Patenting biological products, Patentable and non patentable inventions in India, grant of patents, Grant process and requirements,

UNIT III (12L)
Introduction and Overview of Biosafety, Categories and Cartagena protocol .Good laboratory biosafety practices

UNIT IV (12L)
Genetic technologies – an overview of Genetic screening for any predisposition symptoms, Cancer screening, Cloning, Gene therapy, DNA fingerprinting,(Paternity and Forensics) in vitro fertilization, surrogate motherhood, PGD, transgenic organisms, xenotransplantation, GMOs.

UNIT V (12L)
Ethical issues – ethical issues against molecular technologies.
Bioethics – Necessity of Bioethics, Scope of bioethics, different paradigms of Bioethics – National & International.

Learning Resources:
1. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology, by Padma Nambisan
2. Bioethics and Biosafety, by M K Sateesh

Subject Name: Environmental Biotechnology	**Category: DSE-3**
Subject Code: BSBIND601(B)	**Semester: 6**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	BSBIND601(B).1: Demonstrate various conventional fuels and their environmental impact.	I
2	BSBIND601(B).2: Identify the processes of bioremediation of soil & water	II

	contaminated with oil spills, heavy metals and detergents.	
3	BSBIND601(B).3: Describe Treatment of municipal waste and Industrial effluents.	III
4	BSBIND601(B).4: Illustrate the concept of Bioleaching.	IV

Course Contents:

UNIT I (15L)
Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol

UNIT II (15L)
Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by microorganisms- degradation of aromatic and chlorinates hydrocarbons and petroleum products.

UNIT III (15L)
Treatment of municipal waste and Industrial effluents. Bio-fertilizers, Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT IV (15L)
Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

Learning Resources:
1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer

7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy

Subject Name: Project/ Dissertation	**Category: DSE-4**
Subject Code: BSBIND602	**Semester: 6**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

BSBIND602.1: Demonstrate appropriate referencing and develop skills in other aspects of academic writing.
BSBIND602.2: Identify, summarise and critically evaluate bioinformatics literature and write a literature review of this field.
BSBIND602.3: Demonstrate knowledge and understanding of report writing.A project work should be done individually under the guidance of one faculty member on any topic related to the subject & can be recorded as dissertation & also be presented by the candidate in front of externals in a seminar.

Subject Name: Basic Mathematics	**Category: GE1**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes:

Sl No	Course Outcome	Mapped Unit
1	GE1.1: Apply number system, theory of equations and determinants.	I, II
2	GE1.2: Apply the biological problem solving with the help of matrix formulation	III, IV, V

3	GE1.3: Select tools for differentiation, partial differentiation and integration.	VI, VII
4	GE1.4: Distinguish vectors and scalars and apply numerical analysis methods for biological problem solving.	VIII, IX, X

Course Contents:

UNIT I (6L)
Number System: Basic idea about number theory
UNIT II (65L)
Theory of Equations Polynomials, Division Algorithm, Remainder Theorem, Fundamental Theorem of Algebra, Descartes' Rule of signs, Relation between roots and coefficients of an equation, Symmetric functions of the roots, Transformation of equations, Cardan's solutions of equations
UNIT III (6L)
Determinant Definition of determinant, Properties of determinant, Minor of an element in a determinant, Co-factor of an element in a determinant, Cramer's Rule for solutions of linear equations
UNIT IV (6L)
Matrix Definition of Matrix, Different types of Matrices, Matrix operations, solution of linear equations using matrix inversion method
UNIT V (6L)
Differentiation Meaning of Differentiation, Standard formulae, Differentiation of a function of a function, Successive Differentiation
UNIT VI (6L)
Partial Differentiation Definition of Partial Differentiation, Successive Partial Differentiation
UNIT VII (6L)
Integration Definition of Integration (Indefinite), Fundamental Theorems, Standard formulae, Method of Substitution, Method of By Parts, Definition of Definite Integration, Fundamental Theorem of Integral Calculus, Properties of Definite Integrals
UNIT VIII (6L)
Differential equation (Ordinary and Partial) Formation of ordinary and partial differential equation, solution techniques, applications, system of ordinary differential equation
UNIT IX (6L)
Vector calculus Operation on vectors and scalar functions, differentiations and integration of vector functions, applications
UNIT X (6L)

Numerical Analysis Solution of equations and differential equations using numerical techniques

Learning Resources:

1. Higher Engineering Mathematics by B.S.Grewal, S. Chand, 43rd Edition 2015
2. Engineering Mathematics by Pal And Bhunia, OXFORD University Press.
3. Introductory Methods of Numerical Analysis by Sastry S.S, PHI.
4. Ordinary And Partial Differential Equations by Dr.M.D.Raisinghania, S.CHAND
5. Introduction to Partial Differential Equations by Rao Sankara, Prentice-Hall Of India Pvt. Limited, 2006.

Subject Name: Introduction to Probability-Statistics	**Category: GE2**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	GE2.1: Apply probability and random variables, various discrete and continuous probability distributions with their properties and their applications in physical and engineering environments.	I, II, III, IV of Section 1
2	GE2.2: Demonstrate the basic ideas of statistics with different characterization of a univariate and bivariate data set.	I, II, III, IV of Section 2
3	GE2.3: Apply statistical tools for analyzing data samples and drawing inference on a given data set.	V, VI, VII of Section 2

Course Contents:

Section 1: Probability

UNIT I (6L)
Basic Concepts: Random experiment, Sample space, Events space and Classical definition of Probability with examples. Conditional probability, Independent events.

UNIT II (6L)
Random Variables:
Discrete random variables, Infinite sequences of Bernoulli trials, The Binomial distribution, Poisson approximation to the Binomial distribution, Sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Covariance and Correlation coefficient.

UNIT III (6L)
Continuous random variables and their properties, Probability density function and distribution function related to a continuous random variable with examples. Uniform, Exponential, Gamma and Normal Distributions with their properties and Applications

UNIT IV (4L)
Chebyshev's Inequality (Statement only) and related sums

Section 2: Statistics

UNIT I (5L)
Data: Collection, Editing and Presentation of Data: Primary data and secondary data; Diagrammatic representation of data: Line diagrams, Bar diagrams, Pie charts and divided-bar diagrams.

UNIT II (6L)
Frequency Distributions: Frequency distributions of discrete and continuous variables, Bivariate and Multivariate Frequency Distributions. Diagrammatic representation of a frequency distribution: Column diagram, Frequency polygon, Histogram and Ogive

UNIT III (6L)
Measures of Central tendency:
Characteristics of a good measure; Arithmetic Mean; Median; Other positional measures – quartiles, deciles, percentiles; Mode

UNIT IV (5L)

Measures of Dispersion:
Meaning and objective of dispersion; Characteristics of a good measure of dispersion; Different measures of dispersion – Range, Quartile deviation, Mean deviation, Mean Absolute deviation, Standard deviation, Measures of relative dispersion – Coefficient of Variation

UNIT V (2L)
Skewness and Kurtosis:
Moments, Measures of Skewness and Kurtosis and their significance,

UNIT VI (3L)
Regression Analysis
Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. 5L

UNIT VII (6L)
Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations. Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes. 12L

Learning Resources:

1. Applied Statistics and Probability for Engineers, 6ed, ISV, by Douglas C. Montgomery and George C. Runger
2. Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, by J. Susan Milton and Jesse Arnold
3. An Introduction to Probability and Statistics, 2ed, by Vijay K. Rohatgi and A.K. Md. Ehsanes Saleh

Subject Name: Biomathematics	**Category: GE3**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	GE3.1: Apply basic mathematical concepts commonly used in Biotechnology.	I
2	GE3.2: Demonstrate the design and analysis of algebraic and calculus methods	II
3	GE3.3: solve problems based on basic analytical techniques	III, IV
4	GE3.4: Apply biomathematics knowledge to real-life problems in research.	V

Course Contents:

UNIT I (15L)

Algebra:

Linear Algebra: - Rank of Matrix by Diagonalization method, Eigen value &eigen Vector

Vector Algebra: - Vector addition, Vector multiplication (dot & cross product), There geometrical meanings, Simple properties (without proof) with simple examples, Vector triple product with simple examples.

Abstract Algebra: - Relation-definition, example, binary relation, construction of function from relation. Mapping, Composite mapping, with simple examples.

Group- Definition with examples, Sub- group-- its definition & Examples, Necessary & Sufficient condition for a subgroup, characterization of a sub-group, order of a group, Cyclic group –its definition, simple properties & examples.

Geometry: 3D Straight Line.

UNIT II (15L)

Calculus – I [For functions of single variable]

Limit, Continuity, Differentiation (including differentiability), Successive Differentiation, Expansion of Functions – Rolle's theorem, Mean Value theorem, Integration – Definite and Indefinite (ordinary, method of substitution, special trigonometric function, partial fraction) Application of integration to find area, Differential equations --homogeneous and Linear ODE's and its simple applications to biological problems.

Calculus – II [For functions of two variables]

Partial Differentiation including Euler's theorem and its application.

Sequence: Its definition, Convergence, Types of sequences, Simple examples of finding limits of simple sequences

UNIT III (15L)

Sequence: Its definition, Convergence, Types of sequences, Simple examples of finding limits of simple sequences. Series: - Logarithmic series, Exponential series, Convergence of series-

Absolute convergence, Test of convergence- Comparison test, D'Alembert Ratio test, Raabe's test, Cauchy's Root test, P-series Test, Leibinitz test for alternating series (Only simple examples without proof). Power Series - Its definition, Convergence, radius convergence.

UNIT IV (15L)

Differentiation: Existence of differentiation, Expansion of function – Rolle's Theorem (Statement only), Langrange's mean value theorem (with proof), Cauchy's mean value theorem (Statement only), Verification of each by simple examples. Integration- Improper integration, Beta & Gamma function- statement and only examples.Fourier series- Definition and simple problems assuming convergence condition, D statement of Dirichlet's condition.

UNIT V (15L)

Differential equation – Linear ODE of second Order.

Learning Resources:

Higher Engineering Mathematics by B.S.Grewal, S. Chand, 43rd Edition 2015
2. Engineering Mathematics by Pal And Bhunia, OXFORD University Press.
3. Introductory Methods of Numerical Analysis by Sastry S.S, PHI.
4. Ordinary And Partial Differential Equations by Dr.M.D.Raisinghania, S.CHAND
5. Introduction to Partial Differential Equations by Rao Sankara, Prentice-Hall Of India Pvt. Limited, 2006.

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Subject Name: Plant and Animal tissue Culture	**Category: GE4**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	GE4.1: Identify the principle behind tissue culture methods.	I, II
2	GE4.2: Select the methodologies of tissue culture.	III, V
3	GE4.3: Describe different kinds of nutrient media and their utility.	IV
4	GE4.4: Illustrate cloning and organ culture and their importance.	VI, VII

Course Contents:

UNIT I (8L)
Introduction to Techniques
Introductory history, Laboratory organization, Media, Aseptic manipulation.

UNIT II (8L)
Basic concepts in cell culture- cell culture, Cellular Totipotency.

UNIT III (8L)
In vitro culture: approaches & methodologies - preparation steps for tissue culture, surface sterilization of plant tissue material, basic procedure for aseptic tissue transfer, incubation of culture.

UNIT IV (8L)

Tissue nutrition: Growth Hormones - Plant cells (Composition of culture media, Growth hormones, Vitamins, Unidentified supplements, selection of media); Animal cells (substrate on which cells grow, Feeder layer on substrate, gas phase for tissue culture, media and supplements).

UNIT V (8L)

Tissue culture methodologies - Plant cells (Types of cultures -Callus Culture, Cell Suspension Culture, Organ Micro-culture, plant micro-propagation, Somatic Embryogenesis); Animal cells (Source of tissue, primary culture, differentiation of cells, growth kinetics, animal cell lines and their origin and characterization).

UNIT VI (12L)

Cloning & Selection of specific cell types – cloning, somatic cell fusion and HAT selection, Medium suspension fusion, selection of Hybrid clone, production of monoclonal antibodies.

UNIT VII (8L)

Organ Culture - Culture of embryonic organs, whole embryo culture, culture of adult organs.

Learning Resources:

1. Introduction to Plant Cell, Tissue and Organ Culture, by Sunil D. Purohit
2. Plant Tissue Culture: Practices and New Experimental Protocols, by B.N. Sathyanarayana and Dalia B. Varghese

Subject Name: Biotechnology and Human Welfare	**Category: GE5**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	GE5.1: Identify the importance of various fields of biotechnology e.g. Agricultural, pharmaceutical and industrial biotechnology and their contribution for human	I, II

	welfare.	
2	GE5.2: Relate current experimentation in biotechnology and genetic engineering.	III
3	GE5.3: Show the benefits of biotechnology in forensic science and crime detection by employing various molecular biology techniques	IV, V

Course Contents:

UNIT I (20L)

Industrial production of Alcohol and antibiotic (Penicilin)

UNIT II (8L)

Application of biotechnology in agriculture, N2 fixation, transfer of pest resistance genes to plants.

UNIT III (8L)

Application of biotechnology in environments: e.g. chlorinated and non-chlorinated organic pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT IV (12L)

Application of biotechnology in forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V (12L)

Application of biotechnology in health, Basic concept of therapy.

Learning Resources:

1. Biotechnology, by U Satyanarayana
2. A Textbook Of Biotechnology, by R C Dubey

Subject Name: Numerical Methods	**Category: GE6**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	GE6.1: Solve the nonlinear equations using different numerical methods	I
2	GE6.2: Solve 1st order differential equations using different numerical methods.	II
3	GE6.3: Solve interpolation related problems using different methods	III
4	GE6.4: Solve numerical integration using different methods	IV
5	GE6.5: Solve the linear equations using different numerical methods.	V

Course Contents:

UNIT I (12L)
Introduction, Bisection Method, Regula-Falsi method, Newton-Raphson method, Secant method
UNIT II (12L)
Differential equation solution- Taylor' Seizes method, Euler's method, RK method, Predictor-Corrector method
UNIT III (12L)
Interpolation- Lagrange method, Newton's forward and backward method, Symbolic representation,
UNIT IV (12L)
Numerical Integration- Trapezoidal rule, Simpsons' 1/3 rule
UNIT V (12L)
Gauss elimination method, Gauss Jordon method, LU matrix factorization method, Gauss-Seidal method

Learning Resources:
1. Introduction to Numerical Analysis – by Sahajahan Ali Mollah
2. Numerical Methods – by B.S. Grewal
3. Numerical methods programming – by Balaguruswamy

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Subject Name: Inheritance Biology	**Category: GE7**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	GE7.1: Identify the strong foundation on Mendelian Genetics, chromosome theory and inheritance pattern.	I
2	GE7.2: Describe basic processes like crossing over and linkage and extension of Mendelism.	II
3	GE7.3: Apply knowledge of Non-Mendelian inheritance and cytoplasmic inheritance	III
4	GE7.4: Describe chromosome mapping; gene order and map distance calculation	IV
5	GE7.5: Interpret Pedigree to identify the pattern of inheritance of a disease	V

Course Contents:

UNIT I (12L)
Science of Genetics – an overview of modern history of Genetics before 1860, 1860-1900, 1900-1944, 1944-Present.).
Mendelism & Chromosome Theory– Mendel's principles, applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human (Sex-linked, Autosomal, Unifactorial, Multi-factorial).
Extension of Mendelism– Deviation from Mendel's Dihybrid phenotype, Bateson & Punnet's Coupling & Repulsion hypothesis.

UNIT II (12L)
Linkage & Crossing over- Chromosome theory of Linkage, kinds of linkage, linkage groups, Sutton's view on linkage, Morgan's view on linkage, types of Crossing over, mechanism of Meiotic Crossing over, theories about the mechanism of Crossing over, cytological detection of

Crossing over, significance of Crossing over.
Allelic Variation & Gene function– Multiple allele, Epistatic and Non-Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism, Modifier/Modifying genes.

UNIT III (12L)
Non-Mendelian inheritance– Evidences for Cytoplasmic factors, cytoplasmic inheritance, extra-nuclear inheritance (mitochondrial, chloroplast), Kappa articles in Paramoecium, Sigma factor in Drosophila, Cytoplamic Male Sterility (CMS) in maize maternal inheritance, uniparental inheritance, non-chromosomal inheritance.

UNIT IV (12L)
Chromosome Mapping- Haploid mapping (2 point & 3-point cross), Diploid mapping (Tetrad analysis), determination of linkage groups, determination of map distance, determination of gene order, cytological mapping.

UNIT V (12L)
Pedigree analysis– Symbols of Pedigree, Pedigrees of Sex-linked & Autosomal (dominant & recessive), Mitochondrial, Incomplete dominance & Penetrance.

Learning Resources:
1. Genetics by Stickberger
2. Genetics by Tamarin& Robert
3. Genetics by Gardner
4. Theory and Problems in Genetics by Stansfield
5. Introduction to Genetic Analysis by Suzuki, Griffith, Richard Lewontin
6. CytoGenetics - Swanson

Subject Name: Ecology and Environment Management	**Category: GE8**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	GE8.1: Identify the importance of the environment and ecosystem.	I
2	GE8.2: Select the strategy to save the environment.	II
3	GE8.3: Explain the pollutants present in the environment and their side effects.	III
4	GE8.4: Describe the biotechnological approaches for plastic and other hazardous chemical free environments.	IV

Course Contents:

UNIT I (15L)
Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

UNIT II (15L)
Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N, C, P cycles).

UNIT III (15L)
Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations, Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup: Case studies.

UNIT IV (15L)

Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.

Learning resources:

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge, University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing, House
4. Joseph, B., Environmental studies, Tata Mc Graw Hill.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5thedition) Books/Cole, Thompson Learning, Inc.
7. Mohapatra Textbook of environmental biotechnology IK publication.
8. Rana SVS, Environmental pollution – health and toxicology, Narosa Publication
9. Sinha, S. 2010. Handbook on Wildlife Law Enforcement in India. TRAFFIC, India.
10. Thakur, I S, Environmental Biotechnology, I K Publication.

Subject Name: Entrepreneurship Developments	**Category: GE9**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	GE9.1: Describe the basic factors and features of entrepreneurship.	I
2	GE9.2: Select the methods of business organization and project formulation.	II, III
3	GE9.3: Apply the financial and marketing strategy to become a successful entrepreneur.	IV, V

Course Contents:

UNIT I (10L)

INTRODUCTION Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II (10L)

ESTABLISHING AN ENTERPRISE Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

UNIT III (10L)

FINANCING THE ENTERPRISE Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital. management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV (15L)

MARKETING MANAGEMENT Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT V (15L)

ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS Meaning of International business, Selection of a product, Selection of a market for international Business, Export financing, Institutional support for exports.

Learning Resources:

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand &Sons.

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Subject Name: Genetics	**Category: GE10**
L-T-P: 6-0-0	**Credit: 6**

Course Outcomes: After completion of the course the students will be able to:

Sl No	Course Outcome	Mapped Unit
1	GE10.1: Illustrate Prokaryotic Genomes, Mechanism of genetic exchange, Transcriptional regulation in prokaryotes.	I
2	GE10.2: Describe genome organization and fine structure of the Gene,	II
3	GE10.3: Identify unique genetic features of plants, Genes controlling flower development in Plants.	III
4	GE10.4: Explain Genome Organization and Function, Cis-acting elements and Trans-acting factors.	III
5	GE10.5: Compute chromosomal variation in Number & Structure and describe Human Cyto-Genetics	IV

Course Contents:

UNIT I (15L)
Prokaryotic Genomes - Physical organization of bacterial genomes (Structure of the bacterial nucleoid, Replication and partitioning of the bacterial genome and Genome of Archaea). (3 L)
Mechanism of genetic exchange: Plasmid and bacterial sex, Types of plasmids (F Plasmid : a Conjugate plasmid', Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility), Episomes.. (5 L)
Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation); Operon concept – lac, trp, Ara operons. Transduction (Generalized transduction, Specialized Transduction)- gene mapping. (5 L)
UNIT II (15L)

Genome organisation and Fine structure of the Gene: Genes and Gene numbers, C value paradox, Denaturation and Renaturation of DNA- Tm values and Cot curves, Repetitive and non-repetitive DNA, Inverted and Tandem repeats, Satellite DNA, Gene Clusters-Histone, rRNA (6 L)
Eukaryotic Chromosome- Macro-molecular organization. Primary and Secondary constriction, Sat-bodies, telomeres. Heterochromatin and Euchromatin and its significance. Ultra structure of chromosome- Nucleosome model and Nucleosome Structure. (7 L)

UNIT III (15L)

Unique genetic features of plants - Ability to photosynthesize, Totipotency of plant cells, Hermaphroditism and ability to reproduce both sexually and asexually, Double fertilization, Alternation of generations, Mitosis in haploid state. (5 L)
Genes controlling flower development in Plants – genes responsible for steps of flower development, genes for floral organ identity, MADS-Box genes, molecular expression of floral organ genes and floral commitment genes. (5 L)
Genome Organization and Function - Analysis of Genomes by Re-association Experiments, , Organization of Single-copy Sequences, Chloroplast Genome Organization, Mitochondrial Genome Organization, RNA editing. (6 L)
Cis-acting elements and Trans-acting factors – Regulatory sequences that control gene expression, Enhancer and Silencer elements, role of 3' sequences, role of introns, conserved sequences in Eukaryotic promoters, Cis-acting elements, Trans-acting factors, Transposon tagging of Plant genes – Mc Clintock and the Ac-Ds transposable elements of Corn, (6 L)

UNIT IV (15L)

Chromosomal variation in Number & Structure– Euploidy, Non-disjunction & Aneuploidy, Aneuploid segregation in plants and animal, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosome in Diptera, structural chromosomal variation, Chromosomal aberrations & evolution. (6 L)
Human Cyto-Genetics– Human karyotype, Banding techniques, classification, use of Human Cyto-genetics in Medical science, , viable monosomies & trisomies, chromosomal deletions & duplications, genetics of chromosomal inversions & translocations, human traits, (6 L)

Learning Resources:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.4. Theory and problems in Genetics by Stansfield.