**CENTRE FOR BIOTECHNOLOGY AND BIOINFORMATICS**
**DIBRUGARH UNIVERSITY**

OUTLINE OF POST GRADUATE SYLLABUS (CBCS MODE) passed in BoS held on ….....

## FIRST SEMESTER

| Course Code | Course Title | | Credits | Total Marks |
|---|---|---|---|---|
| CORE COURSES (CC) | | | | |
| CC – 101 | Cell and Developmental Biology | | 4 | 100 |
| CC – 102 | Fundamentals of Biochemistry and Bio Analytical Techniques | | 4 | 100 |
| CC – 103 | Basic Microbiology | | 4 | 100 |
| CC – 104 | Lab I | | 3 | 75 |
| DISCIPLINE SPECIFIC ELECTIVES (DSE) | | | | |
| **DSE (THEORY)** | DSE(T) - 101 | DBMS – I | 3 | 75 |
| | DSE(T) - 102 | Plant Biotechnology - I | 3 | 75 |
| | DSE(T)- 103 | Applied Microbiology - I | 3 | 75 |
| | DSE(T) - 104 | Biochemistry - I | 3 | 75 |
| | DSE(T) - 105 | Integrative Biology - I | 3 | 75 |
| | DSE(T) - 106 | Drug Discovery - I | 3 | 75 |
| **DSE (PRACTICAL)** | DSE(P) - 101 | Lab Course on DSE(T) - 101 | 1 | 25 |
| | DSE(P) - 102 | Lab Course on DSE(T) - 102 | 1 | 25 |
| | DSE(P)- 103 | Lab Course on DSE(T) - 103 | 1 | 25 |
| | DSE(P) - 104 | Lab Course on DSE(T) - 104 | 1 | 25 |
| | DSE(P) - 105 | Lab Course on DSE(T) - 105 | 1 | 25 |
| | DSE(P) - 106 | Lab Course on DSE(T) - 106 | 1 | 25 |
| ABILITY ENHANCEMENT COURSES (AEC) | | | | |
| AEC – 101 | IPR, Biosaftey and Bioethics | | 2 | 50 |
| AEC – 102 | Computer Application | | 2 | 50 |

**Total Credits: 21**

## SECOND SEMESTER

| Course Code | Course Title | | Credits | Total Marks |
|---|---|---|---|---|
| CORE COURSES (CC) | | | | |
| CC – 201 | Bioinformatics and Biostatistics | | 4 | 100 |
| CC – 202 | Genetics | | 4 | 100 |
| CC – 203 | Molecular Biology | | 4 | 100 |
| CC – 204 | Lab II | | 3 | 75 |
| DISCIPLINE SPECIFIC ELECTIVES (DSE) | | | | |
| **DSE (THEORY)** | DSE(T) - 201 | DBMS – II | 3 | 75 |
| | DSE(T) - 202 | Plant Biotechnology - II | 3 | 75 |
| | DSE(T)- 203 | Applied Microbiology - II | 3 | 75 |
| | DSE(T) - 204 | Biochemistry - II | 3 | 75 |
| | DSE(T) - 205 | Integrative Biology - II | 3 | 75 |
| | DSE(T) - 206 | Drug Discovery - II | 3 | 75 |
| **DSE (PRACTICAL)** | DSE(P) - 201 | Lab Course on DSE(T) - 201 | 1 | 25 |
| | DSE(P) - 202 | Lab Course on DSE(T) - 202 | 1 | 25 |
| | DSE(P)- 203 | Lab Course on DSE(T) - 203 | 1 | 25 |
| | DSE(P) - 204 | Lab Course on DSE(T) - 204 | 1 | 25 |
| | DSE(P) - 205 | Lab Course on DSE(T) - 205 | 1 | 25 |
| | DSE(P) - 206 | Lab Course on DSE(T) - 206 | 1 | 25 |
| GENERIC ELECTIVES (GE) | | | | |
| GE (T) – 201 | Biological Database Design | | 3 | 75 |
| GE (P) – 201 | Biological Database Design | | 1 | 25 |

**Total Credits : 23**

**THIRD SEMESTER**

| Course Code | Course Title | Credits | Total Marks |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| CORE COURSES (CC) | | | | |
| CC – 301 | Genomics and Proteomics | | 4 | 100 |
| CC – 302 | Immunology | | 4 | 100 |
| CC – 303 | Genetic Engineering | | 4 | 100 |
| CC - 304 | Bioprogramming with C | | 4 | 100 |
| CC - 305 | Lab III | | 3 | 75 |
| DISCIPLINE SPECIFIC ELECTIVES(DSE) | | | | |
| **DSE (THEORY)** | DSE(T) - 301 | DBMS – III | 3 | 75 |
| | DSE(T) - 302 | Plant Biotechnology - III | 3 | 75 |
| | DSE(T)- 303 | Applied Microbiology - III | 3 | 75 |
| | DSE(T) - 304 | Biochemistry - III | 3 | 75 |
| | DSE(T) - 305 | Integrative Biology - III | 3 | 75 |
| | DSE(T) - 306 | Drug Discovery – III | 3 | 75 |
| **DSE (PRACTICAL)** | DSE(P) - 301 | Lab Course on DSE(T) - 301 | 1 | 25 |
| | DSE(P) - 302 | Lab Course on DSE(T) - 302 | 1 | 25 |
| | DSE(P)- 303 | Lab Course on DSE(T) - 303 | 1 | 25 |
| | DSE(P) - 304 | Lab Course on DSE(T) - 304 | 1 | 25 |
| | DSE(P) - 305 | Lab Course on DSE(T) - 305 | 1 | 25 |
| | DSE(P) - 306 | Lab Course on DSE(T) - 306 | 1 | 25 |
| ABILITY ENHANCEMENT COURSES (AEC) | | | | |
| AEC– 301 | Research Methodology | | 2 | 50 |
| GENERIC ELECTIVES (GE) | | | | |
| GE (T)– 301 | *In vitro* Culture Techniques | | 3 | 75 |
| GE (P)– 301 | *In vitro* Culture Techniques | | 1 | 25 |

**Total Credits : 29**

**FOURTH SEMESTER**

| Course Code | Course Title | Credits | Total Marks |
|---|---|---|---|
| CORE COURSES (CC) | | | |
| CC – 401 | Bioprocess Engineering | 4 | 100 |

| | | | |
|---|---|---|---|
| CC – 402 | Structural Biology | 4 | 100 |
| CC – 403 | Bioprogramming with Java | 4 | 100 |
| CC - 404 | Lab IV | 3 | 75 |
| DISCIPLINE SPECIFIC ELECTIVES (DSE) | | | |
| DSE(P) - 401 | Project Work on DSE(T) 101 - DSE(T) 301 | 4 | 100 |
| DSE(P) - 402 | Project Work on DSE(T) 102 - DSE(T) 302 | 4 | 100 |
| DSE(P)- 403 | Project Work on DSE(T) 103 - DSE(T) 303 | 4 | 100 |
| DSE(P) - 404 | Project Work on DSE(T) 104 - DSE(T) 304 | 4 | 100 |
| DSE(P) - 405 | Project Work on DSE(T) 105 - DSE(T) 305 | 4 | 100 |
| DSE(P) – 406 | Project Work on DSE(T) 106 - DSE(T) 306 | 4 | 100 |

**Total Credits: 19**

**SEMESTER WISE DISTRIBUTION OF CREDITS**

| SEMESTER | CORE COURSE (CC) | DISCIPLINE SPECIFIC ELECTIVES (DSE) | ABILITY ENHANCEMENT COURSES (AEC) | GENERIC ELECTIVES (GE) | TOTAL |
|---|---|---|---|---|---|
| I | 15 | 4 | 2 | - | 21 |
| II | 15 | 4 | | 4 | 23 |
| III | 19 | 4 | 2 | 4 | 29 |
| IV | 15 | 4 | | | 19 |
| GRAND TOTAL | 64 | 16 | 4 | 8 | 92 |

## FIRST SEMESTER SYLLABUS

**NAME OF THE COURSE:** **CELL AND DEVELOPMENTAL BIOLOGY**
**COURSE CODE:** **CC-101**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**
1. To have a basic understanding of fundamentals of cell structure and function.
2. To have a lucid understanding of the cellular processes of signaling and transport
3. To have a comprehensive understanding of the cellular changes that lead to malignancy

4. To elucidate the different developmental pathways lead to both morphogenesis and organogenesis in both animals and plants
5. To develop skills, through lab experiments and exercises, in specific methodologies used in the study of modern cell biology.

**CREDIT POINTS: 4**
**TOTAL MARKS: 100**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | **Cellular Organization**<br>History and evolutionary timeline of Cell Biology, Internal Organization of The Cell: Membrane Structure, Membrane Transport of Small Molecules and the Electrical Properties of Membranes, Organelles- their morphologies and functions, Intracellular Vesicular Traffic and Protein sorting, Energy Conversion: Mitochondria and Chloroplasts;<br>The Cytoskeleton, Protein Trafficking, Techniques to study cellular movement and expression of proteins: Green Fluorescent Protein and Fluorescence Microscopy | 7 |
| 2 | **Cellular interaction and communications**<br>**Interaction between Cells and their environment:** extra-cellular space and components of extracellular matrix, interaction of cells with ECM, Plant Cell walls<br>**Cell-Cell communication**<br>Cellular Junctions and Cell Adhesion,<br>**Cell Signaling**<br>Mechanisms of cell communication: Cell signaling and mechanism of signal transduction; | 7 |
| 3 | **Cell cycle**<br>Cell division, cellular checkpoints and regulation of the cell cycle, cell death and Apoptosis, | 7 |
| 4 | **Oncology**<br>Origin of cancer, carcinogens, Cellular changes during malignancy, Metastasis, Genes Involved in Cancer. | 6 |
| 5 | **Concepts in developmental Biology**:<br>Potency, commitment, specification, induction, competence, determination and differentiation; Imprinting, | 6 |
| 6 | **Gametogenesis and Differentiation**<br>Sexual Reproduction: Meiosis, Germ Cells, and Fertilization, Morphogenetic gradients; Cell fate and Cell lineages; Genomic equivalence and the cytoplasmic determinants; Cell differentiation during gametogenesis and embryo formation, Development of Specialized Tissues, Stem Cells, and Tissue Renewal | 7 |
| 7 | **Morphogenesis and organogenesis in animals**<br>Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development and regeneration in vertebrates differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development, Homeotic genes in Animals | 7 |

| | | |
|---|---|---|
| 8 | **Morphogenesis and organogenesis in plants**<br>Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum, Homeotic genes in Plants | 7 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

. The students will have

- strong underpinning of fundamentals of cell structure and function.
- lucid understanding of the cellular processes of signaling and transport
- a comprehensive understanding of the cellular changes that lead to malignancy
- strong underpinning of fundamentals of the different developmental pathways that lead to both morphogenesis and organogenesis in both animals and plants

**RECOMMENDED READINGS:**

1. Molecular Biology of the Cell. Alberts et al. Garland Science, 18-Nov-2014
2. Molecular Cell Biology, Harvey Lodish, W. H. Freeman, 2008
3. Schaum's Outline of Molecular and Cell Biology, William Stansfield, Jaime S. Colomé, Raúl J. Cano, McGraw Hill Professional, 22-Sep-1996
4. Essential Cell Biology. Bruce Alberts. Garland Pub., 1998
5.Cell and Molecular Biology: Concepts and Experiments, Gerald Karp, 8th edition, Wiley

**NAME OF THE COURSE:** **FUNDAMENTALS OF BIOCHEMISTRY & BIOANALYTICAL TECHNIQUES**
**COURSE CODE:** **CC-102**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**

1. The course is designed to provide an insight into the structure and function of biomolecules, their chemical and physical properties and catalysis.
2. Further, the course deals with the principles of instrumental methods for the qualitative and quantitative analysis of biological samples with the objective to familiarize students with the fundamental principles and working of spectroscopy, microscopy and other similar

techniques.

**CREDIT POINTS:** **4**
**TOTAL MARKS:** **100**

| Unit | Content | Contact Hours |
|---|---|---|
| **1.** | Fundamentals of thermodynamic principles applicable to biological processes. Significance of water in biochemistry; acid-base concept, buffers, pH and pK.Hydrogen bonding, hydrophobic, electrostatic and Van der Waals interactions. Energy rich compounds- sources and utilization. | 6 |
| **2.** | Introduction to biomolecules- Classification, structure, functions and metabolism of carbohydrates, proteins, lipids and nucleic acids. Introduction to enzymes: nomenclature, classification, mechanisms and biological roles. | 10 |
| **3.** | General introduction to analytical instrument and equipment. Operation and safety measures in biology laboratory. Good Laboratory Practices. | 4 |
| **4.** | Spectroscopy: Theory, instrumentation & applications of- UV-VIS spectrophotometry, IR spectroscopy, Mass Spectrometry and NMR. | 8 |
| **5.** | Separation techniques:<br>Chromatography: Principle, types and applications of different chromatographic methods. Partition and Adsorption chromatography, Ion-exchange chromatography, Size exclusion and affinity chromatography.<br>Electrophoresis: Theory, instrumentation and applications. Native PAGE, SDS PAGE, Agarose gel electrophoresis.<br>Centrifugation: Working principle, types and applications. | 12 |
| **6.** | Microscopy: Principle, working and applications. Light, electron and Confocal Microscopy. | 8 |

**MODE OF ASSESSMENT:**

- Assignments,
- Quizzes
- Internal
- Assessments

**EXPECTED LEARNING OUTCOME:**

- At the end of the course, the student is expected to comprehend the role and significance of biomolecules.
- Further, the student is anticipated to develop an understanding of the working and application of the various instruments used in a biology laboratory.

**RECOMMENDED READINGS:**


- Modern Analytical Chemistry, David Harvey, McGraw-Hill, 1st ed, 2000, ISBN: 0–07–237547–7
- Chemical Analysis: Modern Instrumentation Methods and Techniques, Francis Rouessac,

AnnickRouessac, John Wiley & Sons, 2nd ed, 2007.ISBN: 0470859040, 9780470859049

- Principles of Instrumental Analysis", D. A. Skoog, F. J. Holler, S.R. Crouch, Brooks Cole; 6th edition (Dec 6 2006) , ISBN: 0495012017 , 978-0495012016
- Physical Biochemistry by David Freifelder

| | |
|---|---|
| **NAME OF THE COURSE:** | **BASIC MICROBIOLOGY** |
| **COURSE CODE:** | **CC-103** |
| **COURSE TYPE:** | **CORE** |
| **COURSE STRUCTURE:** | **L-4 T-0 P-1** |

**COURSE OBJECTIVES:**

It would be expected that after completing this course a student would

1. Have an in-depth knowledge about the diversity of microorganisms and a comprehensive understanding of the basic techniques employed for their isolation, characterization and culture.

2. Have a basic understanding of microbial genetics
3. Be able to conceptualize the fundamental principles underlying host-pathogen interactions and disease development

**CREDIT POINTS: 4**
**TOTAL MARKS: 100**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| **UNIT 1** | History of microbiology, structure of bacteria; nutrition, growth medium, methods of sterilization; pure culture, isolation, selective method of isolation, cultivation, preservation. | 8 |
| **UNIT 2** | Metabolic diversity among microorganisms: Heterotrophs, organotrophs (methane utilization, hydrocarbon transformation); autotrophs, phototrophs; chemolithotrophs; (iron, sulfur utilizing microbes) and their importance in biotechnology | 8 |
| **UNIT 3** | Microbial genetics: Transformation–competence, molecular mechanism of transformation conjugation; generalized transduction, specialized transduction plasmids; types of plasmids,. Transposons and transposable elements, mapping of bacteria. | 8 |
| **UNIT 4** | Microbial diversity, Systematic bacteriology, new approaches to bacterial taxonomy (ribotyping). Extremophiles: Archaea (characters and types), acidophilic, alkalophilic, thermophilic, barophilic and osmophilic microbes, methanogens, methane production;. Biotechnological potential of extremophiles. Viruses: General characters, chemical nature, structure of TMV, HIV, bacteriophages, Viroids and Prions, lytic and lysogenic cycles. | 8 |
| **UNIT 5** | Host-Parasite Relationships: Normal microflora of skin, oral cavity, Gastrointestinal tract. | 8 |
| **UNIT 6** | Microbial Diseases: Tuberculosis; Cholera, Malaria and HIV, Sexually transmitted diseases including AIDS; Pathogenic fungi; Emerging and resurgent infectious diseases- bacteria, protozoa. Antibiotics and probiotics (source, mode of action). | 8 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

The students will have:

- Thorough knowledge and understanding of the core concepts in the discipline of

Microbiology.

- Knowledge on how microorganisms are used as model systems to study basic biology, genetics, metabolism and ecology.

**RECOMMENDED READINGS:**


1. Microbiology: A Text Book of Microorganisms,General and Applied,Charles Edward marshall,F.TBioletti Published P. P.Blakiston's son &co.
2. Microbiology , M.J Pelczer and R.D Reid.
3. General Microbiology- by R. Y. Stanier .et.al
4. Soil Microbiology- by S. A. Walman
5. Microbiology, by Prescott, Tata MacGrawHill


| | |
|---|---|
| **NAME OF THE COURSE:** | **LAB-I** |
| **COURSE CODE:** | **CC-104** |
| **TOTAL CREDIT ASSIGNED:** | **3** |
| **MARKS:** | **75** |
| **DISTRIBUTION OF CREDITS :** | **L-0 T-0 P-3** |

**CONTENTS**

**Microbiology Practicals**

1. Cleaning and sterilization of glass wares.

2. Preparation of liquid and solid media for growth of microorganism and pure culture technique.
3. Isolation and enumeration microorganisms from mixed population.
4. Microbial colony characterization in different media.
5. Microbial sub-culturing and preservation techniques.
6. Various Staining techniques.
7. IMViC test.
8. Starch hydrolysis test.
9. Catalase test
10. Fermentation of carbohydrates.
11. Hydrogen sulphide production test.
12. Urease test.
13. Oxidase test.
14. Gelatin hydrolysis test.

**Cell and developmental Biology**

1. Study of different stages of mitosis in Onion root tip cell
2. Staining of mitochondria in human cheek epithelial cell
3. Study of Baar body in buccal epithelial cell
4. Study of Cell viability assay by trypan blue exclusion

**Lab exercises based on the above:**

1. Numerical problems based on the preparation of standard solutions of different molarity, normality, strength and percentage.
2. Preparation of buffer solutions.
3. Verification of Beer-Lambert's law and determination of absorption coefficients.
4. Paper chromatography – Separation of amino acids/carbohydrates.
5. Thin layer chromatography- separation of carbohydrates/proteins/phytochemicals.
6. Column chromatography- separation of carbohydrates/proteins/phytochemicals.
7. Electrophoresis- PAGE/SDS PAGE of proteins, Separation of DNA fragments on Agarose gel.
8. Preparation of slides for microscopic observation of- bacteria, fungi, plant and animal cells/tissues.

**NAME OF THE COURSE:** **DBMS I (FUNDAMENTAL CONCEPTS OF DBMS)**
**COURSE CODE:** **DSE(T)-101**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**Course Objectives:**

1 To enable students to understand and use a relational database system. Introduction to Databases, Conceptual design using ERD, Functional dependencies and Normalization, Relational Algebra and Relational Calculus.
2 To enable students perform conceptual and logical database design with various case studies

**CREDIT POINTS: 3**

**TOTAL MARKS: 75**

| | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Overview of Database System: History of Database System, File System Vs DBMS, Advantages of DBMS, Levels of Abstraction in DBMS, Data Independence, Transaction Management, Structure of DBMS | 6 |
| UNIT 2 | Introduction to Database Design: Entities, Attributes and Entity Sets, Relationship and Relationship Sets, Entity Relationship Model (ER Model), Features of ER Model – Key Constraints, Participation Constraints, Weak Entities, Class Hierarchies, Aggregation | 6 |
| UNIT 3 | Conceptual Design with ER Model: Entity Vs Attributes, Entity Vs Relationships, Binary Vs Ternary Relationships, Aggregation Vs Ternary Relationships, Case Studies | 7 |
| UNIT 4 | Logical Database Design: Entity Sets to Tables, Relationship Sets (without constraints) to Tables, Translating Relationship Sets with Key Constraints, Participation Constraints, Translating Weak Entity Sets, Class Hierarchies, Translating ER Diagram with Aggregation, Case Studies | 7 |
| UNIT 5 | Introduction to Views, Data Independence, Security, Destroying/Altering Tables and Views | 5 |
| UNIT 6 | Relational Algebra and Calculus: Relational Algebra (Selection & Projection, Set operations, Renaming, joins, Division), Relational Calculus (Tuple Relational Calculus, Domain Relational, Calculus) | 8 |

**Mode of Assessment/Assessment Tools:**

- Internal written exam
- Group Discussion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

After successful completion of course learner will be able

a) To understand fundamental concepts of database and DBMS
b) To develop ER model for any given case studies including biological case studies
c) To translate ER model
d) To formulate various queries with relational algebra and calculus

**NAME OF THE COURSE: Lab course on DSE(T)-101**
**COURSE CODE: DSE(P)-101**
**TOTAL CREDIT ASSIGNED : 1**

**MARKS: 25**

1. Draw ER Diagram for the given Case Studies

a) Non Biological Cases: University Management System, Online Shopping.

b) Biological Cases: Enzyme, Vitamin and Hormones Database, Target-drug-Phytochemical Database

2. Write Relational Algebra Queries on the above mentioned databases.

**RECOMMENDED READINGS:**


1. Database Management Systems, Ramakrishnan, Gehrke, International Edition, McGRAW-HILL

2. Fundamentals of Database System,Elmarsri, R.Navathe, S.B Benjamin Cummings Publishing Company.

**3.** An Introduction to Database Systems,BipinC. Desai,Revised Edition.Galgotia Publications Pvt.Ltd.


**NAME OF THE COURSE: PLANT BIOTECHNOLOGY- I**
**COURSE CODE: DSE(T)-102**
**COURSE TYPE: DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT: L -3 T-0 P-1**

**COURSE OBJECTIVES:**

1. This subject aims to introduce students to the field of modern Biotechnology, with emphasis on plant research and the Agricultural revolution.
2. This course will also impart knowledge on basic concepts about the principles and techniques in Plant Tissue Culture.

3. The students will also learn about the principles underlying the protocols for different types of cultures, as well as gain hands-on experience in laboratory practicals about the same.

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | Brief History of Modern Biotechnology- Genetics and Plant Breeding, Agricultural Revolution, Tissue Culture, Recombinant Plant products, Plant genomics, Industrial agriculture | 9 |
| 2 | Laboratory Organization- Washing, Sterilisation, Media preparation facilities and instruments, Transfer areas, Culturing facilities- light units, Green houses | 9 |
| 3 | Nutrition medium: Facilities and equipment, Units for solution preparation, Media composition: Carbon and energy sources, vitamins, growth regulators, organic supplements, gelling agents, role of pH | 9 |
| 4 | Sterilisation Techniques: Wet and Dry heat sterlisation, Filter sterilization, UV sterlisation; Sterilisation of explants, Maintenance of aseptic conditions | 7 |
| 5 | Different types of cultures: Seed culture, Embryo culture, Callus culture, Endosperm culture; Cytodifferentiation, Organogenic differentiation | 5 |

**MODE OF ASSESSMENT:**

- Internal written exam
- Group Discussion
- Quiz
- Seminar

**NAME OF THE COURSE: Lab course on DSE(T)-102**
**COURSE CODE: DSE(P)-102**
**TOTAL CREDIT ASSIGNED : 1**
**MARKS: 25**

1. Handling and Operation of Tissue Culture equipments
2. Sterilisation Techniques
3. Media preparation
4. Callus culture
5. Artificial seed production

**RECOMMENDED READINGS:**


6. Plant Tissue Culture: Theory and Practice. S.S. Bhojwani, M.K. Razdan, Elsevier, November 1996
7. Plant Tissue Culture Techniques and Experiments. Roberta H. Smith. Academic Press; 3rd edition (August 3, 2012)
8. Plants from Test tubes- An Introduction to Micropropagation. Holly Scoggins and Mark Bridgen. Timber Press; Fourth Edition, Revised edition (August 13, 2013)
9. Plant Biotechnology: The Genetic Manipulation of Plants. Slater, Scott, Fowler. Oxford University Press; 2 edition (June 2, 2008)
10. Introduction to Plant Biotechnology. H.S. Chawla. CRC Press, 2009


**NAME OF THE COURSE:** **APPLIED MICROBIOLOGY-I (ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY)**
**COURSE CODE:** **DSE(T)-103**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**

- The students would concentrate on principles of Environmental and Agricultural Microbiology
- Students will become familiar with the technical aspects of these areas of Microbiology and their pertaining to real-life significance through technology involved in the gaining of in-

depth knowledge in these areas.

**CREDIT POINTS: 3**

**TOTAL MARKS: 75**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Microbes in agriculture: N2 fixation, Biofertilizer, mycorrhizae, Vermicomposting; Biopesticides and bioinsecticides: Integrated pest management (IPM); Microbial plant hormones. | 6 |
| UNIT 2 | Food and dairy microbiology - Microbial production of SCP and edible mushroom, Microbial production of flavours and fragrances, Probiotics and neutraceuticals, Fermented dairy products and Fermented foods. | 6 |
| UNIT 3 | Environmental Microbiology: Understanding environmental problems and monitoring, environmental impacts and their assessments using bioindicators, Bioremediation: Principles, Strategies and techniques of bioremediation. | 6 |
| UNIT 4 | Geomicrobiological processes: Microbial enhanced oil recovery (MEOR); Microbiology of minerals: Bioleaching of minerals; Acid mine drainage formation and control. | 6 |
| UNIT 5 | Microbial indicators of water pollution, Waste treatment; Biological methods of solid and liquid waste treatment; Environmental laws and policies in India. | 6 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

The students will have knowledge on:

- The role of microorganism in recycling soil nutrients, biodegradation of complex polymers, sustaining and improving plant growth through improving nutrient availability.
- The need for environmental and agricultural microbiology and their limitations.
- Application of microorganisms in varied fields of agricultural and environmental microbiology like bioremediation, biofertilizers and waste water treatment.

**NAME OF THE COURSE: Lab Course on DSE(T) - 103**
**COURSE CODE: DSE(P)- 103**
**CREDIT: 1**
**MARKS: 25**

**List of practical:**

- Microbial analysis of dairy products.
- VAM staining.
- Isolation and characterization of probiotic strains from various sources.
- Isolation and characterization of hydrocarbon degrading microbes.
- Extraction of microbial biosurfactants.
- Determination of emulsification index of biosurfactant/surfactants.
- Determination of foaming index of surfactants.
- Drop collapse assay.

**RECOMMENDED READINGS:**

1. Microbiological Examination of Water and Wastewater By Maria Csuros; CRC Publishing House
2. Textbook of Environmental Microbiology By Pradipta K. Mohapatra; I. K. International Pvt Ltd.
3. Environmental Microbiology (Second Edition) *Edited by: Ian L. Pepper, Charles P. Gerba, Terry Gentry and Raina M. Maier; Elsevier LLC.*
4. Agricultural Microbiology by Rangaswami G; MT Publishers.

**NAME OF THE COURSE: BIOCHEMISTRY- I (BIOMOLECULES)**
**COURSE CODE: DSE(T)-104**
**COURSE TYPE: DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT: L -3 T-0 P-1**

**COURSE OBJECTIVES:**

1. The course is designed to provide an insight into the structure and function of biomolecules, their chemical and physical properties and catalysis.
2. The course introduces the students to biological catalysts, their mechanisms of action and kinetics.

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| Unit | Contents | Contact Hours |
|---|---|---|
| **1.** | **Carbohydrate:**Structure, general properties and functions of polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins | **6** |
| **2.** | **Proteins:**Chemistry of amino acids and proteins. Hierarchy of protein structure. Ramachandran Plot. Purification of proteins, peptide sequencing. | **7** |
| **3.** | **Nucleic acids:**Nucleic acids as genetic information carriers, experimental evidence e.g., genetic transformation, Hershey-Chase experiment. Chemistry, structure and function of nucleosides and nucleotides. | **7** |
| **4.** | **Enzymes:** General characteristics, nomenclature, IUB enzyme classification, measurement and expression of enzyme activity, enzyme assay. Definitions of IU, Katal, enzyme turnover and specific activity. Methods for isolation, purification and characterization of enzymes.<br>Nomenclature and classification. Cofactors and coenzymes- role in enzyme catalysis, ribozymes, isozymes, abzymes. Vitamins, their coenzyme forms and functions. | **9** |
| **5.** | **Lipids:**Chemistry and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrocides, steroids, bile acids, prostaglandins, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides. | **5** |

**MODE OF ASSESSMENT:**

- Assignments,
- Quizzes,
- Internal Assessments

**EXPECTED LEARNING OUTCOME:**

- At the end of the course, the student is expected to comprehend the role and significance of biomolecules.
- Further, the student is anticipated to develop an understanding of enzyme catalyzed reactions and their kinetics.

**NAME OF THE COURSE: Lab Course on DSE(T) - 104**
**COURSE CODE: DSE(P)- 104**
**CREDIT: 1**
**MARKS: 25**

**List of practical:**

1. Estimation of total carbohydrates by Anthrone method.
2. Quantification of reducing sugars by Dinitrosalicylic acid method.
3. Estimation of proteins by Lowry and Bradford assays.

4. Estimation of DNA by diphenylamine method.
5. Quantification of RNA by orcinol method.
6. Protein precipitation and purification

**Recommended Readings:**


- Berg J.M., TymoczkoJ.L., Stryer L. Biochemia. PWN Warszawa 2007
- Nelson DL and MM Cox. Lehninger Principles of Biochemistry (5th edition). ("Lehninger")
- Loertscher J and V Minderhout. Foundations of Biochemistry (3rd edition). ("FOBC")
- Moran, Horton, Scrimgeour, & Perry. Principles of Biochemistry, 5th Edition, Pearson Publishing © 2011
- Murray R.K., Granner D.K., Mayes P.A., Rodwell V.W. Harper's Illustrated Biochemistry. Lange Medical Books 2003

**NAME OF THE COURSE:** **INTEGRATIVE BIOLOGY I (BIOSYSTEMS AND COMPUTATIONAL BIOLOGY)**
**COURSE CODE:** **DSE(T)-105**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**
The course will provide the student with knowledge about modern approach to contemporary biology (integrative biology).
It would be expected that after completing this course a student would:

1. understand the role if information technology in modern biology
2. feel comfortable in operate in unix based platform for analysis of biological problems
3. have a strong confidence in taking up mathbio problems
4. have a understanding of the foundation and application of various information to study at molecular genetics
5. have a understanding of the foundation and principle behind System science in moden biology

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | **Information technology used in Integrative Biology**<br>Introduction to Information Technology and computers, Hardware and software. Introduction to computational biology | 5 |
| 2 | **Unix/Linux in Biology:**<br>introduction, various distribution of linux, Structure of linux OS, structure of file systems, linux commands, accessing permission,<br>Uses of linux in Biology, | 8 |
| 3 | **Basic of Mathematics and Statistics**<br>Having fun with numbers: Set theory,<br>algebra, and probability<br>Calculations in integrative Biology and Biotechnology | 10 |
| **4** | **Evolutionary genomics**<br>Evolution: Definition, scope and applications, Theories of evolution, natural selection and neutral theory, phylogeny. Significance of Evolutionary genomics in contemporary Biology. | 8 |
| 5 | **System and Network Biology**<br>Introduction to Systems Biology, the motivation for applying a systems Biology / network Biology point of view to molecular biology problems. Use of integrative Biology in clinical sciences, pharmacological, and functional genomics studies | 5 |
| 6 | **Application of Computational Biology:**<br>scope and application of computational Biology; **Bio-Databases: Sequence & Structure Databases::** GenBank, EMBL, DDBJ, Uniprot-KB: SWISS-PROT, PDB, ACeDBs, literature databases-PubMed; Webtools: ExPASy server | 3 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discussion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

After successful completion the student will

1. be able to acknowledge the role of information technology in modern biology
2. be able to feel operate in unix based platform for analysis of biological problems
3. be able to take up mathbio problems
4. be able to comprehend the concept and application of various information to study at molecular genetics
5. be able to comprehend the foundation and principle behind System science in moden biology
6. be able to take up hypothesize and design research experiment.

**NAME OF THE COURSE: Lab Course on DSE(T) - 105**
**COURSE CODE: DSE(P)- 105**
**CREDIT: 1**
**MARKS: 25**

**List of practical:**

a) Numerical problems in Biotechnology and integrative biology

b) Working with Linux commands and modifying file type

**c)** Creating a basic phylogenetic tree and inferring from it.

d) Exploring various Databases and tools and their respective uses.

**RECOMMENDED READINGS:**


1. Genetics: The continuity of life, D. J. Fairbanks and W. H. Andersen, Brooks/Cole Pub., 1999
2. Introduction to Genetic Analysis- Vol. 10, Anthony J.F. Griffiths, W. H. Freeman, 2008
3. LazebnikY. A., Cancer CELL, Vol. 2, pp. 179-182 (2002).
4. Frank H stephenson. Calculatios for Molecular Biology and Biotechnology.Academic Press

**NAME OF THE COURSE:** **DRUG DISCOVERY – I (PRINCIPLES OF DRUG DESIGN)**
**COURSE CODE:** **DSE(T)-106**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVE:**

The course will enable the students to understand the basic principles involved in new drug discovery with emphasis on lead identification, lead optimization, classification and kinetics of molecules targeting enzymes and receptors, prodrug design and applications, as well as structure-based drug design methods

Upon completion of this course the student should be able to:

1. Understand the process of drug discovery and development
2. Identify novel drug targets for introduction of new drugs into clinical practice

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| UNITS | CONTENT | HOURS |
|---|---|---|
| UNIT 1 | Introduction to the Drug Discovery and Development:<br>Definition of various terms, Physical-chemical factors and biological activities, Rational Approach to Drug Design, Sources of lead compounds, Stages and Strategic Issues of Drug Development | 6 |
| UNIT 2 | Approaches for New Drug Discovery:<br>Drugs Derived from Natural Products, New Drug Discovery from Natural Sources, Disease Models for New Drug Leads, Physiological Mechanism, Approaches for Lead Optimization | 8 |
| UNIT 3 | Enzymes as Targets of Drug Design:<br>Enzyme kinetics, Enzyme inhibition and activation, Approaches to the Rational Design of Enzyme Inhibitors | 8 |
| UNIT 4 | Receptors as Targets of Drug Design:<br>Receptor Theory, Receptor Models and Nomenclature, Molecular Biology of Receptors, Receptor Complexes and Allosteric Modulators, Second and Third Messenger Systems, Receptor Binding Assays, Lead Compound Discovery of Receptor agonists and antagonists | 8 |
| UNIT 5 | Prodrug Design and Applications:<br>Prodrug Forms of Various Functional Groups, Prodrug Design Considerations, Drug release and activation mechanisms, Applications | 6 |

**MODE OF ASSESSMENT:**

- Assignments,
- Quizzes,
- Internal Assessments

**EXPECTED LEARNING OUTCOME:**

- After completion of the course the learner is expected to acquire knowledge on drug discovery and development.

**NAME OF THE COURSE: Lab Course on DSE (T) - 106**
**COURSE CODE: DSE (P)- 106**
**CREDIT: 1**
**MARKS: 25**

**List of practicals:**

1. Preparation of derivatives of lead molecules and study of Biological activities
2. Estimation of enzyme activity
3. Preparation of prodrugs

**RECOMMENDED READINGS:**


- Kerns, E.H.; Di, L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008
- Burger's Medicinal Chemistry and Drug Discovery, 5th Edition, Vol. 1, Principles and Practice, edited by M. E. Wolff, John Wiley & Sons: New York, 1995.
- Principles of Medicinal Chemistry, 4th Edition, edited by W.O. Foye, T.L. Lemke, and D. A. Williams, Williams and Wilkins: Philadelphia, 1995.
- Medicinal Chemistry: Principles and Practice, edited by F.D. King, Royal Society of Chemistry: Cambridge, 1994.
- A Practical Guide to Combinatorial Chemistry, A. W. Czarnik and S. H. DeWitt (Ed), American Chemical Society, Washington DC, 1997.

**NAME OF THE COURSE:** **IPR, BIOSAFETY AND BIOETHICS**
**COURSE CODE:** **AEC - 101**
**COURSE TYPE:** **ABILITY ENHANCEMENT COURSES (AEC)**
**DISTRIBUTION OF CREDIT:** **L -2 T-0 P-0**

**COURSE OBJECTIVES:**

1. This subject aims to introduce students to Intellectual Property Rights and apprise them of ethical issues in the biological sciences and the laws pertaining to these in both the global and national context.
2. This course would help students to also adhere to the ethical practices appropriate to the various scientific disciplines at all times and to adopt safe working practices relevant to the different biotech industries & fields of research.

**CREDIT POINTS:** **2**

**TOTAL MARKS:** **50**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Concept of Property<br>Tangible and Intangible Property, Classification of Intellectual Property- Patents, Copyright, Trademark, Industrial Design, Geographical Indications, sui-generis rights (Protection of Plant Varieties and Traditional Knowledge), Relevance of Intellectual Property Rights for Science and Technology | 4 |
| UNIT 2 | International Conventions relating to Intellectual Property;<br>General Agreement on Trade and Tariff (GATT); Trade Related Aspects of Intellectual Property Rights (TRIPS); Establishment of WIPO – Mission and Activities; Indian IPR legislations | 4 |
| UNIT 3 | Nature, Origin and Scope of Patents;<br>Essentials of Patents- Patentability Criterion-Discovery and Invention<br>Patentability of Biotechnology Inventions;<br>Patent Laws in Indian and International Perspective;<br>Patent Case study: Basmati Case, Neem Controversy, Turmeric Case | 6 |
| UNIT 4 | Biosafety: Definition and requirement;<br>International Legal Instruments on Biosafety-Cartagena Protocol on Biosafety, Nagoya Protocol<br>Laws relating to Biosafety in India: The Biological Diversity Act, 2002, Biosafety procedures, rules and guidelines under Environment (Protection) Act 1986 and Rules 1989;<br>Biosafety Regulation: Principles and Practices in Microbial and Biomedical Labs | 6 |
| UNIT 5 | Basic Principles of Bioethics;<br>Bioethics in Plants, Animals and Microbial Genetic Engineering;<br>Ethical issues in Healthcare;<br>Biopiracy and Bioethics | 4 |

**RECOMMENDED READINGS:**


11. Cornish, W. R., Intellectual Property (Latest Edition)
12. Intellectual Property Rights by Paul Goldstein
13. Intellectual Property Rights by K. R. G. Nair, Ashok Kumar, K. R. G. Nair
14. Kilner, John, et.al, eds., Cutting-Edge Bioethics. Eerdmans 2002.
15. B.L. Wadera, Patents, Trademarks, Copyright, Designs and Geographical Indications
16. S. Ignacimuthu, Bioethics, Alpha Science International, Limited (2009)
17. Matthew Rimmer, Intellectual Property and Biotechnology: Biological Inventions (2008)
18. Arthur L. Caplan, Robert Arp, Contemporary Issues in Bioethics (2014)
19. Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights: Legal and Social Implications Springer (India) (2014) (in press)
20. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New York 1996.
21. Govindarajan M, Natarajan S, Senthil Kumar V. S, " Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

**NAME OF THE COURSE:** **COMPUTER APPLICATION**
**COURSE CODE:** **AEC - 102**
**COURSE TYPE:** **ABILITY ENHANCEMENT COURSES (AEC)**
**DISTRIBUTION OF CREDIT:** **L -1 T-0 P-1**

**COURSE OBJECTIVES:**
The objective of the course is

1. To enable learners to understand basics of computer science
2. To enable learners to work efficiently on computer systems for day to day activities

**CREDIT: 2**
**MARKS: 50**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Fundamentals of Computer: Basic Computer Organization, Knowledge on Input, Output, Processing and Memory Units; Concepts of Software and Computer Languages | 5 |
| UNIT 2 | Operating System: Basic Concepts, DOS/Linux Commands | 8 |
| UNIT 3 | MS Office – MS Word , MS Excel and MS power point; | 8 |
| UNIT 4 | Internet : Basic Concepts and Usage of Internet, Concept of Server and Client, Internet Protocols | 5 |

**MODE OF ASSESSMENT:**

a) Internal written exam
b) Group Discussion
c) Quiz
d) Seminar

**EXPECTED LEARNING OUTCOME:**

- After successful completion of course learner will be able to use computer for various word processing, spread sheet and presentation needs, learner will also be able to use Internet for various academic needs.

**RECOMMENDED READINGS:**

1. P K Sinha. Computer Fundamentals. BPB Publications; Reprint Edition 2018
2. V. Rajaraman, Neeharika Adabala, Fundamentals of Computers, PHI, EEE 6th Edition
3. E. Balagurusamy Fundamentals of Computers. Mcgraw Hill 2009
4. S Jain. MS-OFFICE 2010 Training Guide ; S Chand publishers, 2010

## SECOND SEMESTER SYLLABUS

**NAME OF THE COURSE:** **BIOINFORMATICS AND BIOSTATISTICS**
**COURSE CODE:** **CC-201**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**
The objective of the course is

1) To impart knowledge on basic techniques of Bioinformatics.
2) To impart basic statistical methods and techniques

**CREDIT POINTS:** **4**
**TOTAL MARKS:** **100**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Fundamentals of Bioinformatics, Biological Databases and Tools: Sequence and Structure Databases, Basic Bioinformatics Tools | 4 |
| UNIT 2 | **Sequence Analysis:** Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues. **Scoring matrices:** basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, matrix derivation methods and principles, **Sequence alignment:** Basic concepts of sequence alignment, Uses of Sequence Alignment | 8 |
| UNIT 3 | **Phylogenetic analysis:** Basic concepts, Methods in evaluation of phylogeny and steps in constructing alignments and phylogenetic Trees, Principle of phylogenetic inferences. | 8 |
| UNIT 4 | **Descriptive Statistics:** Introduction to data types**;** Measures of central tendency and dispersion, **Simple Correlation and Regression** | 6 |
| UNIT 5 | **Concepts of probability:** Random experiment, probability, different laws, conditional probability, Random variables and probability distributions (Binomial, Poisson, Normal, Extreme value distributions) | 5 |
| UNIT 6 | **Sample survey:** Basic of sample survey and various sampling methods **Statistical inference:** Classical estimation theory and classical testing of hypothesis, p-Value, **Test of significance:** Students t-test (one and two), chi-square test, non-parametric tests. Analysis of variance (one way and two way classifications). | 9 |
| UNIT 7 | **Multivariate statistical techniques**: Cluster analysis, Principal component analysis and Discriminant analysis | 4 |

**MODE OF ASSESSMENT:**

- Internal written exam
- Group Discussion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

After successful completion of course learner will be able

1. Use Databases and Basic Bioinformatics Tools
2. Perform Basic Statistical Methods in Biological Data Analysis

**RECOMMENDED READINGS:**


1. Cynthia Gibas, Per Jambeck**.** Developing Bioinformatics Computer Skills, O'Reilly
2. Dan E. Krane 2003. Fundamental Concepts of Bioinformatics. Pearson Education India
3. Stanley. LetovskyBioinformatics: Databases and Systems, Springer
4. David W. Mount**.** Bioinformatics: Sequence and Genome Analysis, Published CSHL Press
5. Des Higgins, Willie R. Taylor**.** *Bioinformatics*: Sequence, Structure and Databanks: *A Practical Approach*, Oxford University Press.
6. Higgs, P. G. & Attwood, T. K. 2005. Bioinformatics and Molecular Evolution. Blackwell Science. Distributed by Ane Books, New Delhi.
7. Stekel, D. 2003. Microarray Bioinformatics. Cambridge University Press. London.
8. Xu, J. & Zhang. 2004. Current Topics in Computational Molecular Biology. MIT Press. Distributed by Ane Books, New Delhi.
9. Jones. 2004. Introduction to Bioinformatics Algorithms. Ane Books, India.
10. Wang. 2005. Data Mining in Bioinformatics. Ane Books, India.
11. Hall. 2004. Phylogenetic Trees Made Easy. W H Freeman & Co. USA.
12. Felsenstein. 2003. Inferring Phylogenies. W H Freeman & Co. USA.
13. Applied Statistics Process , B. Biswas, New Central Book Agency, Kolkata
14. Genetics of Population, J.P Jain and V.T Pravakaran South Asian Publishers (P) Ltd. New Delhi.
15. Statistical techniques for studying genotype-environment introduction, V.T Pravakaran and J.P. Jain.
16. A Biostatistical and population oriented Approach, South Asian Publisher (P) Ltd. New Delhi.
17. Statistical methods in Bioinformatics – Warren J. Ewens, G.R. Grant, Springer New York.
18. Statistical methods in molecular Biology, H.Bang, X.K.Zhou, H.L.Epps, M.Mazumdar, Springer, ISBN 978-1-60761-578-1

**NAME OF THE COURSE:** **GENETICS**
**COURSE CODE:** **CC-202**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**

1. To have a basic understanding of the founding concepts of Genetics and Cytogenetics
2. To discern the significance of extra-chromosomal inheritance and its effect on consecutive generations
3. To comprehend the significant consequences of any change in genetic constitution resulting in disease and disorder
4. To understand the dynamics of population genetics
5. To decipher the use of markers to create linkage maps

**CREDIT POINTS:** **4**
**TOTAL MARKS:** **100**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | **Mendelian Genetics:**<br>Background, history and Concept of inheritance, Mendel's experiment: Monohybrid experiment and principle of Segregation, Dihybrid experiment and law of Independent Assortment, Dominance Mendelian Inheritance in Humans with examples. | 7 |
| 2 | **Variation in Mendelian Genetics:**<br>Deviation from Mendelism- Multiple Alleles and Dominance Relations, Epistasis Penetrance and Expressivity | 6 |
| 3 | **Chromosome mapping**<br>Linkage studies: The Discovery of Linkage and Crossing-Over, Two-Factor Linkage, Map Distance Correction and mapping function, Three-Factor Linkage, Physical Chromosome Mapping, Practical Applications of Chromosome Mapping, Recombination, Crossing-Over and Complementation. | 7 |
| 4 | **Mutations and Chromosomal aberration**<br>Molecular basis of mutation—types, spontaneous mutation, induced mutations, Radiation and chemical mutagens | 6 |
| 5 | **Extranuclear inheritance**<br>The Origins of Mitochondria and Plastids,<br>Cellular structure and Functions of Mitochondria, Mitochondrial Inheritance,<br>Cellular structure and Functions of Plastids, Plastid Inheritance. | 7 |
| 6 | **Population genetics**<br>Hardy-Weinberg equilibrium,<br>Genetic changes in population, Random and non-random mating, Selection, Genetic drift<br>Speciation: Types, isolation mechanisms leading to speciation | 6 |

| | | |
|---|---|---|
| 7 | **Quantitative genetics**<br>Additive Gene Action and Continuous Variation, Heterosis and Inbreeding Depression, Environmental Variation | 7 |
| 8 | **Genetic disorder and their inheritance**<br>Chromosomal aberration in Humans with examples of consequential disorders and diseases;<br>Sex-Linked disease inheritance,<br>Mitochondial inheritance associated genetic disorders in Humans, Plastid Inheritance associated genetic disorders in plants | 6 |

**MODE OF ASSESSMENT:**

- Internal written exam
- Group Discussion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

1. The students would have a firm grasp on the basic concepts and theories of both classical and modern genetics.
2. They would have a comprehensive and clear understanding of the consequences of change in genetic constitution and also the role of genetic mechanisms in evolution
3. They would be proficient in determination of linkage maps and the mechanism of sex determination
4. The students would also be able to distinguish between chromosomal and extra-chromosomal inheritance and elucidate the genetic mechanisms involved in the same
5. The students would also develop technical skills by performing experiments and exercises on different aspects of genetic analysis.

**RECOMMENDED READINGS:**


1. Genetics: The continuity of life, D. J. Fairbanks and W. H. Andersen, Brooks/Cole Pub., 1999
2. Introduction to Genetic Analysis- Vol. 10, Anthony J.F. Griffiths, W. H. Freeman, 2008
3. Genetics: Analysis of Genes and Genomes, Daniel L. Hartl, Elizabeth W. Jones, Jones & Bartlett Learning, 2009
4. Genetics, Monroe W. Strickburger, Macmillian 1976

**NAME OF THE COURSE:** **MOLECULAR BIOLOGY**
**COURSE CODE:** **CC-203**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES :**

1. The course is designed to introduce students to the concepts of molecular biology and central dogma of life.

**CREDIT POINTS:** **4**
**TOTAL MARKS:** **100**

| Unit | Contents | Contact Hours |
|---|---|---|
| **1.** | Nucleic acid as genetic material, Genome organization in prokaryotes and eukaryotes, chromatin structure and function. Heterochromatin, euchromatin. Histones and non-histone proteins, general properties of histone, nucleosomes, solenoid structure, packaging of DNA, satellite DNA. | 8 |
| **2.** | DNA replication: mechanism, the replicons, origin, primosome & replisomes. Properties of prokaryotic and eukaryotic DNA polymerases.Synthesis of leading and lagging strand. Difference between prokaryotic and eukaryotic replication. | 8 |
| **3.** | Transcription: prokaryotic transcription; promoters, properties of bacterial RNA polymerase, steps: initiation, elongation and termination. Properties of RNA polymerase I, II and III. RNA processing and RNA editing. Inhibitors of transcription. | 8 |
| **4.** | Translation: Ribosomes structure and function, genetic code, aminoacyl tRNA synthases.Direction of protein synthesis (Dintzis experiment).Formation of translation initiation complex, chain elongation, translocation & termination and the role of respective factors involved therein. Post-translational modifications- Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation. Inhibitors of translation. | 8 |
| **5.** | Regulation of Transcription and Translation: Positive and negative control. Repressor & Inducer. Concept of operon- lac-/ ara-/ trp operons. Attenuation and catabolite repression. | 8 |
| **6.** | Nucleases and restriction enzymes, Denaturation of DNA and Reassociation Kinetics.<br>C-value paradox, DNA Sequencing. | 8 |

**MODE OF ASSESSMENT:**

- Assignments,
- Quizzes,
- Internal
- Assessments

**EXPECTED LEARNING OUTCOME:**

- At the end of the course, the student is expected to develop an understanding of the concepts of replication, transcription, translation and other concepts of molecular biology.

**RECOMMENDED READINGS:**


- Molecular Biology of the Gene, James D. Watson, Pearson/Benjamin Cummings, 2008
- Molecular Biology, Robert Weaver, McGraw-Hill Education, 11-Feb-2011
- Molecular Biology of the Cell. Alberts et al. Garland Science, 18-Nov-2014
- Molecular Cell Biology, Harvey Lodish, W. H. Freeman, 2008

**NAME OF THE COURSE:** **LAB-II**
**COURSE CODE:** **CC-204**
**NATURE OF THE COURSE:** **CORE (PRACTICAL)**
**TOTAL CREDITS ASSIGNED** **: 3**
**TOTAL MARKS** **: 75**
**DISTRIBUTION OF CREDITS** **: L-0 T-0 P-3**

## Contents:

**Basic Bioinformatics**

1. Perform Sequence and Structure Retrieval and Analysis

2. Perform Pairwise and Multiple Sequence Alignment

3. Construct and Analyse Phylogenetic Tree

**Genetics**

1. Solving Problems related to Mendelian Genetics
2. Solving Problems related to deviation Mendelian Genetics
3. Solving Problems related to linkage analysis and chromosome mapping
4. Solving Problems related to population genetics
5. Solving Problems related to quantitative genetics
6. Working with OMIM database

**Molecular Biology**

Laboratory exercises based on the above contents
(tentative list)

1. Extraction of DNA/ RNA
2. Quantification of DNA/RNA
3. Quality assessment of DNA
4. Restriction Digestion
5. Hyperchromic effect

**NAME OF THE COURSE:** **DBMS II (ADVANCED DBMS CONCEPTS AND SQL)**
**COURSE CODE:** **DSE(T)-201**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**

1. To enable students to understand the database redundancy and to resolve the redundancy with Normalization, to understand the concepts of Transaction management.
2. To enable the students to understand various database objects and Structured Query Language.
3. To familiarize with MySQL and to enable students to design and develop databases and to enable them to write various SQL queries on the database.

**TOTAL CREDIT:** **3**
**MARKS:** **75**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Normalization: Concept of Data Redundancy and Anomalies in DBMS, Introduction and Importance of Normalization, Normal Forms. Denormalization | 8 |
| UNIT 2 | Transaction Management, Concurrency Control and Crash Recovery | 4 |
| UNIT 3 | Structured Query Language : Data Definition Language (DDL), Data Manipulation Language (DML), Data Control Language(DCL), Transaction Control Language(TCL)<br>Introduction to Various Database Objects (table, index, function, views, store procedure and triggers) | 5 |
| UNIT 4 | Data Definition Language : Create/Alter/Drop Statements for database and database objects, Data Manipulation Language : SELECT/INSERT/UPDATE/DELETE statements, Data Control Language : GRANT/REVOKE statements, Transaction Control Language: COMMIT,ROLLBACK,SAVEPOINT,SET TRANSACTION statements | 9 |
| UNIT 5 | MySQL : MySQL workbench- Modeling and Design tool, SQL development tool, Administration tool, Managing MySQL databases and tables | 4 |
| UNIT 6 | Sorting, filtering and grouping data in MySQL, MySQL Joins, Subqueries, MySQL Set operators, MySQL transaction, MySQL data types, MySQL constraints, MySQL import & export | 9 |

**MODE OF ASSESSMENT:**

a) Internal written exam
b) Group Discussion
c) Quiz
d) Seminar

**NAME OF THE COURSE: Lab Course on DSE(T) - 201**
**COURSE CODE: DSE(P)- 201**
**CREDIT: 1**
**MARKS: 25**

1. Design ER Diagram with **Normalization** on various non biological and biological databases.
2. Map ER Diagram to Database
3. Write SQL Queries on the above databases

**EXPECTED LEARNING OUTCOME:**

After successful completion of course learner will be able

a) To remove database redundancies
b) To design and develop databases using MySQL
c) To write various queries on the databse

**RECOMMENDED READINGS:**


1. SQL: The Complete Reference, James R. Groff, Paul N. Weinberg Published McGraw-Hill Professional.
2. Fundamentals of Database System,Elmarsri, R.Navathe, S.B Benjamin Cummings Publishing Company.
3. Database Management Systems, Ramakrishnan, Gehrke, International Edition, McGRAW-HILL
4. Database System Concepts , 5th Edition , MacGrawHill International, A.Silberschatz,H.F Korth,S.Sudarshan

**NAME OF THE COURSE:** **PLANT BIOTECHNOLOGY- II**
**COURSE CODE:** **DSE(T)-202**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**

1. This subject aims to introduce students to the different advanced techniques of Tissue culture, including Suspension culture and Haploid and Triploid culture.
2. This will be supported by laboratory practicals on the same.
3. This course will also impart knowledge on basic concepts about Protoplast culture as well as Somaclonal variation which is an important phenomenon occurring in cultured plants.
4. The students will also learn about the principles behind the techniques of germplasm conservation and storage.

**TOTAL CREDIT:** **3**
**MARKS:** **75**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | Definition and concept of Micropropagation, Meristem and shoot tip culture and advantages, Axillary bud culture, Organogenesis, Embryogenesis, Advantages and disadvantages of micropropagation | 8 |
| 2 | Cell suspension culture, Single cell cultures, Production of secondary metabolites, Immobilised Cell systems, Biotransformation | 7 |
| 3 | In vitro production of haploids: Anther culture, microspore culture, ovule culture, factors governing success of androgenic and gynogenic cultures, significance and uses of haploids; Triploid culture | 7 |
| 4 | Protoplast Isolation- mechanical and enzymatic methods, Protoplast development, Somatic hybridization by protoplast fusion, Cybrids, Advantages and disadvantages of somatic hybridisation | 7 |
| 5 | Somaclonal variation: Schemes for obtaining somaclonal variation, Applications of somaclonal variation, Advantages and disadvantages of somaclonal variation | 4 |
| 6 | Germplasm conservation and storage techniques- ex situ and in situ. Medium or short-term storage: Cold storage, Modification of gaseous environment, Dessication; Long-term storage: method and requirements of cryopreservation | 6 |

**NAME OF THE COURSE: Lab Course on DSE(T) - 202**
**COURSE CODE: DSE(P)- 202**
**CREDIT: 1**
**MARKS: 25**

1. Shoot tip/ meristem culture
2. Axillary bud culture
3. Pollen culture
4. Protoplast isolation and fusion

**RECOMMENDED READINGS:**

1. Plant Tissue Culture: Theory and Practice. S.S. Bhojwani, M.K. Razdan, Elsevier, November 1996
2. Plant Tissue Culture Techniques and Experiments. Roberta H. Smith. Academic Press; 3rd edition (August 3, 2012)
3. Plants from Test tubes- An Introduction to Micropropagation. Holly Scoggins and Mark Bridgen. Timber Press; Fourth Edition, Revised edition (August 13, 2013)
4. Plant Biotechnology: The Genetic Manipulation of Plants. Slater, Scott, Fowler. Oxford University Press; 2 edition (June 2, 2008)
5. Introduction to Plant Biotechnology. H.S. Chawla. CRC Press, 2009

**NAME OF THE COURSE:** **APPLIED MICROBIOLOGY-II (MEDICAL MICROBIOLOGY)**
**COURSE CODE:** **DSE(T)-203**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**

1. The student will be able to identify common infectious agents and the diseases that they cause.
2. To evaluate methods used to identify infectious agents in the clinical microbiology lab.
3. To explain general and specific mechanisms by which an infectious agent causes disease.

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | General topics on Medical Microbiology: History and development, Koch's postulates. Infection: source, modes of transmission, portal of entry into the susceptible host and prevention. | 6 |
| UNIT 2 | Bacterial pathogenicity, identification of bacteria: staining methods, culture methods, biochemical tests and other recent methods. Sterilization and disinfection. Normal microbial flora, antimicrobial agents. | 6 |
| UNIT 3 | Diseases caused by Gram positive and negative bacteria: sore throat, pneumonia, meningitis, gonorrhoea, Tuberculosis, Diphtheria, Tetanus, Enteric fever, Bacillary dysentery, UTI, Cholera, Plague, Whooping cough, STDs *etc*. | 6 |
| UNIT 4 | Overview of Medical Mycology, Important Fungal Diseases – Superficial, Subcutaneous, Systemic and Opportunistic Mycosis. Overview of Medical Parasitology, Important Protozoan Diseases- Malaria, Leishmaniasis, Amoebiasis, Giardiasis *etc*. Important Helmenthic Diseases- Ascariasis, Ankylostomiasis, Filariasis, Taeniasis, Echinococcosis, Schistosomiasis *etc*. | 6 |
| UNIT 5 | Overview of Medical Virology, Important Viral Diseases– Herpesvirus, Poliovirus, Rabies virus, Arboviruses Hepatites, HIV *etc*. Opportunistic Microbial Infection, Water, Milk and Food borne diseases, Microbial Vaccine. | 6 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

The students will be able to

- Identify common infectious agents and the diseases that they cause.
- Evaluate methods used to identify infectious agents in the clinical microbiology lab.

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| **NAME OF THE COURSE:** | **Lab Course on DSE(T) - 203** |
| **COURSE CODE:** | **DSE(P)- 203** |
| **CREDIT:** | **1** |
| **MARKS:** | **25** |

**List of practical:**

Sterilization techniques
Isolation and screening of *Streptococcus* and *Staphyloccus sp.*
Characterization and identification of *Streptococcus sp.*
Characterization and identification of *Staphyloccus sp.*
Preparation of blood and chocolate agar
Haemolysis assay
Identification of enteric Gram-negative *Bacilli*

**RECOMMENDED READINGS:**

1. Greenwood D (2007). Medical Microbiology. I.K. International.
2. Murray PR, Pfaller MA, Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press.
3. Talaro KP and Talaro A. (2006). Foundations in Microbiology. McGraw-Hill College Dimensi.
4. Willey J, Sherwood L. and Woolverton C (2007). Prescott/Harley/Klein's Microbiology, McGraw Hill.
5. Atlas RM (1997). Principles of Microbiology. McGraw Hill.
6. Nester E.W, Anderson DG and Nester MT (2006). Microbiology. A Human Perspective. McGraw Hill.
7. Harvey, R.A., Champe, P.C. and Fisher, B.D. 2007. Lippincott’s Illustrated Reviews : Microbiology. Lippincott Williams and Wilkins, New Delhi/New York.

**Course Code:** **DSE(T) - 204**
**Course Title:** **BIOCHEMISTRY –II (Enzymology)**
**Nature of the Course :** **DSE**
**Distribution of Credit:** **L-3 T-0 P-0**

**COURSE OBJECTIVES:**

1. The course is designed to provide an insight into biological catalysts, their mechanisms of action and kinetics.

**TOTAL CREDITS:** **3**
**TOTAL MARKS:** **75**

| Unit | Contents | Contact Hours |
|---|---|---|
| **1.** | **Kinetics of enzyme action:** Significance of energy of activation. Concept of ES complex, active site, specificity, Michaelis-Menten equation for uni- substrate reactions. Determination of $K_m$& $V_{max}$ and their significances. Importance of $K_{cat}/K_m$. Influence of *p*H, temperature and substrate concentration on enzyme- catalysed reaction | **8** |
| **2.** | **Mechanism of Enzyme Action:** Acid-base catalysis, covalent catalysis. Chemical modification of active site groups. Mechanism of action of enzymes- chymotrypsin or lysozyme | **8** |
| **3.** | **Enzyme Regulation:** General mechanisms of enzyme regulation, product inhibition. Reversible and irreversible modifications of enzymes. Feedback inhibition and feed forward stimulation. Allosterism & Allosteric enzymes. | **6** |
| **4.** | **Enzyme Inhibition:** Reversible and irreversible inhibition. Competitive, non- competitive, uncompetitive, linear-mixed type inhibitions and their kinetics, determination of $K_i$. Suicide inhibitor. | **5** |
| **5.** | **Multienzyme system:** Significance & properties: Mechanism of action and regulation of multienzyme complex (pyruvate dehydrogenase/ fatty acid synthase). Isoenzymes with special reference to lactate dehydrogenase. RNA as enzymes (ribozymes). Restriction enzymes. | **5** |
| **6.** | **Enzyme Technology:** Enzyme Immobilization: methods and influence on enzyme kinetics. Biosensors- components, working, types and examples. Enzyme Engineering- Strategies for enzyme engineering (Random mutagenesis and Site directed mutagenesis of enzymes). | **5** |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

At the end of the course, the student is anticipated to develop an understanding of enzyme catalyzed

reactions and their kinetics.

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|---|---|
| **NAME OF THE COURSE:** | **Lab Course on DSE(T) - 204** |
| **COURSE CODE:** | **DSE(P)- 204** |
| **CREDIT:** | **1** |
| **MARKS:** | **25** |

List of Practicals

1. 1. Assay of enzyme activity.
2. Isolation and purification of enzyme from microbial/ plant/ animal source (s).
3. Time dependence of enzyme catalysed reaction.
4. Influence of substrate concentration on the rate of enzymatic reaction.
5. Effect of pH and temperature on the rate of enzyme reaction.
6. Specificity of enzyme action.
7. Inhibition of enzyme activity and Determination of $K_i$.
8. Molecular weight determination of enzyme by gel filtration.
9. Immobilization studies:
    a. Immobilization of enzyme by suitable technique (s).
    b. Study of the kinetics of the immobilized enzyme.

Study of reusability and storage stability of the immobilized enzyme.

**Recommended Readings:**


- Berg J.M., TymoczkoJ.L., Stryer L. Biochemia. PWN Warszawa 2007
- Nelson DL and MM Cox. Lehninger Principles of Biochemistry (5th edition). (“Lehninger”)
- Loertscher J and V Minderhout. Foundations of Biochemistry (3rd edition). (“FOBC”)
- Moran, Horton, Scrimgeour, & Perry. Principles of Biochemistry, 5th Edition, Pearson Publishing © 2011
- Murray R.K., Granner D.K., Mayes P.A., Rodwell V.W. Harper’s Illustrated Biochemistry. Lange Medical Books 2003

**NAME OF THE COURSE:** **INTEGRATIVE BIOLOGY II: QUANTITATIVE GENETICS AND EVOLUTIONARY GENOMICS**
**COURSE CODE:** **DSE(T)-205**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**

The course will give the student knowledge about molecular evolutionary processes,
It would be expected that after completing this course a student would:

1. critically comprehend the evolutionary process at the molecular level
2. the foundation of various sequence alignment techniques.
3. have a understand the foundation and application of various molecular methods using biological sequence information to study genetic variation within and between species
4. explain and justify different models of sequence evolution
5. knowledge and skills in different steps in phylogenetic analysis and how this can be used to study (molecular) evolution.
6. have a understanding of basic principles of various algorithms for 2/3 dimensional information using nucleotide sequence.

**TOTAL CREDIT ASSIGNED:** **3**
**TOTAL MARKS:** **75**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | **Evolution of genes in populations**: Hardy-Weinberg equilibrium; genetic variability , Genetic drift; population structure (inbreeding and gene flow),<br>genome composition, complexity: C-value paradox, Transposition, retroposition, and junk DNA. | 7 |
| 2 | **Molecular Evolution**: Understanding the Parity rules for DNA;<br>Selection at the molecular level: variations in substitution rates and their causes in nuclear, organellar, and viral DNA;<br>Natural selection, The neutral and nearly-neutral theories of molecular evolution. Tests of selection.<br>DNA strand asymmetry: AT and GC skews in DNA strands, Mutational bias between the strands and factors responsible, Gene distribution asymmetry, transition and transversion bias, | 7 |
| 3 | **Genetic code and Synonymous codon usage bias**<br>Codon degeneracy, codon usage bias, Principles and methods of quantifying codon usage bias, Codon context, factors responsible for codon usage bias , tRNA modification role, | 7 |
| 4 | **Molecular phylogenetics**<br>Aligning DNA and protein sequences; Divergent and convergent evolution.<br>**Concepts in molecular phylogenetics**: kinds of trees, rooting, clades, trees, phylogeny as hypothesis.<br>Calculating evolutionary distances among sequences; corrections and models, Phylogenetic methods, | 7 |

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|---|---|---|
| 5 | **Mechanisms of Evolution of genome and gene families**<br>horizontal gene transfer and Homology, Genome duplications, and origin of Introns.<br>Inferring gene duplication and losses.<br>Rooting the tree of life with gene families. Reconstructing the evolution of function. | 6 |
| 6 | **Comparative genomics and its biomed application**<br>Concept of LUCA,<br>Orthology and paralogy.<br>Domain shuffling and concerted evolution.<br>Genome projects and comparative mapping and Chromosomal evolution,<br>Disease causing mutations, cancer and evolution of tumor, artificial selection of recessive traits | 7 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

It would be expected that after completing this course a student would have a

a) Working knowledge on sequence alignment techniques and its scope in in solving the complex biological problems.
b) Firm understating of the principles underlying various predictive methods for solving biological problems and.
c) Clear understanding of basic principles of various algorithms used for structural information of nucleotide sequence.
d) Understanding of methodologies involved in and application of conventional phylogenetic clustering analysis of biological sequences.

**NAME OF THE COURSE:** **Lab Course on DSE(T) - 205**
**COURSE CODE:** **DSE(P)- 205**
**CREDIT:** **1**
**MARKS:** **25**

Solving advance numerical problems on population genetics.
Homology search using webservers
Calculating mutational bias between the strands
Finding *ori/ ter* site in a genome.
Calculating codon indices using software tools.
Retrieving Data from database for comparative genomics
Constructing phylogenies using various methodologies

**RECOMMENDED READINGS:**

1) Futuyma, D.J., Evolution, Sinauer Associates publication
2) Graur, D and W H Li. 1999 Fundamentals of Molecular Evolution. 2nd edition Sinauer Associates publication
3) Li, W.H. 1997 Molecular Evolution. Sinaur, Sunderland, MA

4) Bioinformatics: Sequence and Genome Analysis, David W. Mount Published CSHL Press
5) Page, RDM and EC Holmes 1998 Molecular Evolution: A phylogenetic Approach. Blackwell Science, Oxford
6) Higgs, P. G. & Attwood, T. K. 2005. Bioinformatics and Molecular Evolution. Blackwell Science. Distributed by Ane Books, New Delhi.
7) Bergstorm and Dugatkin 2012 Evolution. Norton and Company

**Other recommended Readings and references**

1. Moorhouse. 2004. Bioinformatics Biocomputing and PERL. Ane Books, India. Hall. 2004. Phylogenetic Trees Made Easy. W H Freeman & Co. USA.
2. Felsenstein. 2003. Inferring Phylogenies. W H Freeman & Co. USA.
3. Bioinformatics: A Practical Approach, Des Higgins, Willie R. Taylor Published Oxford University Press.
4. Bioinformatics: Databases and Systems, Stanley. Letovsky Published Springer
5. Developing Bioinformatics Computer Skills, Cynthia Gibas, Per Jambeck Published O'Reilly
6. Hughes, A.L. 1999 Adaptive Evolution of Genes and Genomes. Oxford University Press. New York
7. Molecular Ecology by J.R. Freeland, S.D. Petersen, and H. Kirk (2nd ed., Wiley, 2011)
8. Yang, Ziheng. Computational molecular evolution. Oxford University Press, 2006
9. D.B. Futuyma. Evolutionary Biology, Third Edition. Sinauer, 1997.
10. Schlötterer, C., The evolution of molecular markers- just a matter of fashion? Nature Reviews Genetics, 2004. 5(1): p. 63-69.
11. Jones, A.G., et al., A practical guide to methods of parentage analysis. Molecular Ecology Resources, 2009. 10(1): p. 6-30.
12. Waples, R.S., Genetic estimates of contemporary effective population size: to what time periods do the estimates apply? Molecular Ecology, 2005. 14(11): p. 3335-3352.
13. Tsutsui, N.D., et al., Reduced genetic variation and the success of an invasive species. Proceedings of the National Academy of Sciences, 2000. 97(11): p. 5948-5953.
14. François, O. and E. Durand, Spatially explicit Bayesian clustering models in population genetics. Molecular Ecology Resources, 2010. 10(5): p. 773-784.
15. Manel, S. and R. Holderegger, Ten years of landscape genetics. Trends in Ecology & Evolution, 2013. 28(10): p. 614-621.
16. Hein, J., M.H. Schierup, and C. Wiuf, Chapter 1. The basic coalescent, in Gene Genealogies, Variation and Evolution: A Primer in Coalescent Theory. 2005, Oxford University Press: Oxford. p. 1-32.
17. Ho, S.Y.W., The changing face of the molecular evolutionary clock. Trends in Ecology & Evolution, 2014. 29(9): p. 496-503.
18. Holmes, E.C., Evolutionary history and phylogeography of human viruses. Annual Review of Microbiology, 2008. 62: p. 307-328.
19. Hohenlohe, P.A., P.C. Phillips, and W.A. Cresko, Using population genomics to detect selection in natural populations: key concepts and methodological considerations. International Journal of Plant Sciences, 2010. 171(9): p. 1059-1071.
20. Renaut, S. and L. Bernatchez, Transcriptome-wide signature of hybrid breakdown associated with intrinsic reproductive isolation in lake whitefish species pairs (Coregonus spp. Salmonidae). Heredity, 2010. 106(6): p. 1003-1011.
21. Gillespie, J. H. 2004. Population Genetics: A Concise Guide. Baltimore and London: The Johns Hopkins University Press.
22. Falconer, D. S. & T. F. C. Mackay. 1996. Introduction to Quantitative Genetics. Edinburgh Gate: Longman Group Ltd.
23. Fisher, R.A. (1918). The correlation between relatives on the supposition of Mendelian inheritance. Trans. R. Soc. Edinb. 52:399-433.
24. Wright, S. (1931). Evolution in Mendelian populations. Genetics 16:97-159

**NAME OF THE COURSE:** **DRUG DISCOVERY – II (COMPUTER AIDED DRUG DESIGN)**
**COURSE CODE:** **DSE(T)-206**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVE:**
The course will enable the students to understand the basic concepts in Computer Aided Drug Design, Computational studies of structure and activity relationships of bio molecules, Concept of Homology Modelling and Molecular Modelling. Upon completion of this course the student should be able to:

1. Understand the basic concepts in Computer Aided Drug Design
2. Methods of computational studies in drug design
3. Homology Modelling and Molecular Modelling in drug design

**TOTAL CREDIT ASSIGNED:** **3**
**TOTAL MARKS:** **75**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Computer Aided Drug Designing (CADD):<br>Concept, Role of CADD in Drug Discovery, Methods and Strategies, Study of Drug properties, Data bases (DB, ZINC) | 5 |
| UNIT 2 | Lead Optimization:<br>Ligand-Based and Structure-Based Design, Review of Protein Structures (Primary, Secondary , Tertiary , Quaternary), Viewing Tools and Graphics Tools (Rasmol, Deep View , VMD , Molscript, Raster3D) | 6 |
| UNIT 3 | Homology Modelling:<br>Similarity Searching and Sequence Alignment–BLAST, FASTA, MSA using ClustalW and ClustalX, EMBOSS, Databases (NCBI); Homology Modelling Programs -Swiss-Model, Modeller | 6 |
| UNIT 4 | Molecular modeling:<br>Energy minimization, geometry optimization, conformational analysis, global conformational minima determination; approaches and problems. Bioactive vs. global minimum conformations. Automated methods of conformational search | 6 |
| UNIT 5 | Structure Activity Relationships in drug design:<br>Qualitative versus quantitative approaches, advantages and disadvantages. Random screening, Non-random screening, drug metabolism studies, clinical observations, rational approaches to lead discovery. Homologation, chain branching, ring-chain transformations, bioisosterism. Molecular recognition phenomenon. Structure based drug design, ligand based drug design | 6 |
| UNIT 6 | QSAR:<br>Physico-chemical parameters, Electronic effects, lipophilicity effects, steric effects, 2D QSAR, Hammett equation, Hansch equation, Experimental and theoretical approaches, parameter inter-dependence; case studies. Regression analysis, Descriptor calculation; 3D-QSAR, CoMFA and CoMSIA. | 7 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

- After successful completion of the course, learner is expected to have expertise on basic approaches in Computer Aided Drug Design

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| **NAME OF THE COURSE:** | **Lab Course on DSE(T) - 206** |
| **COURSE CODE:** | **DSE(P)- 206** |
| **CREDIT:** | **1** |
| **MARKS:** | **25** |

**Lab work:**

1. Designing new leads by modifying their functional groups.
2. Homology Modelling
3. 2D QSAR experiments
4. 3D QSAR experiments

**RECOMMENDED READINGS:**


- Burger's Medicinal Chemistry and Drug Design ( All volumes), John Wiley & Sons, Inc., new York.
- Drug design ( All volumes)- E. J. Ariens ( Ed)
- Principles of Medicinal Chemistry, William Foye.
- Quantitative structure activity of Drugs, G. Topliss
- Quantitative Drug design, A critical Introduction, Y. C. Martin.
- Practical Application of Computer Aided Drug Design, P. S. Charifson
- Medicinal chemistry, A. Kar
- A Text Book of Medicinal Chemistry (Vol. I & II), S. N. Pandeya

**NAME OF THE COURSE:** **BIOLOGICAL DATABASE DESIGN**
**COURSE CODE:** **GE(T) - 201**
**COURSE TYPE:** **GENERAL ELECTIVE (GE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-0**

**COURSE OBJECTIVES:**

The objective of the course is

1. To enable learners to understand basics of database and design design process
2. To enable learners to design databases with MySQL and to enable them to issue queries
3. To enable learners to design front end with HTML/PHP
4. To enable learners to design basic web based applications in the field of biological science with PHP and MySQL

**TOTAL CREDIT ASSIGNED:** **3**
**TOTAL MARKS:** **75**

| | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Concepts of Database and DBMS: History of Database System, File System Vs DBMS, Advantages of DBMS, Structure of DBMS | 6 |
| UNIT 2 | Introduction to Database Design: Entities, Attributes and Relationship,ER Model | 6 |
| UNIT 3 | Development of Database : Mapping ER Model to Relational Model | 5 |
| UNIT 4 | Understanding Modeling of Biological Databases | 5 |
| UNIT 5 | Structured Query Language (MySQL), Development of Database with MySQL with Biological Case Studies | 5 |
| UNIT 6 | Basics of HTML/PHP | 8 |
| UNIT 7 | Development of Front End with HTML/PHP | 8 |
| UNIT 8 | PHP-MySQL Connectivity: Connect, Create DB/Table, Select/Insert/Update/Delete Data | 9 |

**MODE OF ASSESSMENT:**

- Internal written exam
- Group Discussion
- Quiz
- Seminar

**NAME OF THE COURSE:** **BIOLOGICAL DATABASE DESIGN**
**COURSE CODE:** **GE(P) - 201**
**COURSE TYPE:** **GENERAL ELECTIVE (GE)**
**DISTRIBUTION OF CREDIT:** **L -0 T-0 P-1**
**TOTAL CREDIT ASSIGNED:** **1**
**TOTAL MARKS:** **25**

**COURSE OBJECTIVES:**

The objective of the course is to give hands-on experience on

1. Database design using My-SQL
2. Development of web application using PHP-MYSQL.

**COURSE CONTENT**

1. Design Entity-Relationship Model on Biological Cases
2. Mapping of ER Diagram to Relational Model
3. Execute Basic SQL Queries
4. Design PHP-MySQL Web Application for various Biological Cases

**EXPECTED LEARNING OUTCOME:**

After successful completion of course learner will be able develop simple web application for biological sciences.

**RECOMMENDED READINGS:**


1. Database Management Systems, Ramakrishnan, Gehrke, International Edition, McGRAW-HILL
2. Powell Thomas. HTML & CSS: The Complete Reference, Fifth Edition. Mcgraw Hill
3. Steven Holzner. PHP: The Complete Reference 2017 McGraw Hill Education
4. Luke WellingLaura Thomson. PHP and MySQL Web Development. Pearson 5th Edition 2016
5. Vikram Vaswani, How to do everything with PHP and MySQL, McGrawHill 2005

## THIRD SEMESTER COURSES

**NAME OF THE COURSE:** **GENOMICS AND PROTEOMICS**
**COURSE CODE:** **CC-301**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**

It is an introductory course where students get a basic knowledge on techniques of Genome and Proteome research.

1. To have a basic understanding of prokaryotic and eukaryotic genome constitution
2. To have a firm underpinning of contemporary genome analysis techniques
3. To have a thorough understanding of contemporary genome sequencing principle and working methodology.
4. To have a lucid understanding of the various regular, contemporary and high throughput proteomic tools, their underlying principles and varied application.
5. To have a comprehensive understanding of protein sequencing and identification techniques and explore its myriad scope and applications

**TOTAL CREDIT ASSIGNED:** **4**
**TOTAL MARKS:** **100**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | **Structural organization of the Genome**:<br>Overview of Prokaryote genome and Eukaryotic nuclear genome, Extra-chromosomal DNA: bacterial plasmids, Eukaryotic organelles genomes (Mitochondria and Chloroplast). | 6 |
| UNIT 2 | **Tools and Techniques in Genomics**<br>Polymerase Chain Reaction (PCR) , RT-PCR, quantitative PCR, other derivatives of PCR methods<br>Various Molecular Probe for quantification<br>Gel Electrophoresis (DNA), Pulse field gel electrophoresis, DNA and RNA Blotting.<br>DNA sequencing methods | 7 |
| UNIT 3 | **Genome mapping**<br>Genetic and physical maps: methods and techniques used for gene mapping, genetic mapping physical mapping, linkage analysis, FISH technique in gene mapping, somatic cell hybridization, *in situ* hybridization comparative gene mapping, time-of-entry mapping , deletion mapping, complementation and recombination in mapping of bacterial chromosome. | 7 |
| UNIT 4 | **Genome Sequencing projects**<br>Principle and methodology of genome sequencing, Genome Sequencing projects: in microbes, plants, and animals<br>Human Genome Project | 7 |

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|---|---|---|
| UNIT 5 | **Introduction to Proteome and proteomics**<br>Aims and strategies in proteomics, proteomics technologies: SDS-PAGE, Native PAGE, isoelectric-focusing and 2D-PAGE, Western blotting, Protein microarray. | 6 |
| UNIT 6 | **Mass spectrometry:**<br>Principles of operation, Types and application: Sector Mass-spectrometer, Quadrupole Mass-spectrometer, ion trap Mass-spectrometer, Time-of flight Mass-spectrometer, Fourier transform Mass-spectrometer; Ionization, ion detection, ion fragmentation, Mass spectrometer in combination with chromatographic methods: MS in combination with HPLC, FPLC,GC | 7 |
| UNIT 7 | **Protein identification and interaction**<br>Peptide sequence determination; Protein identification: Tandem Mass-spectrometer, peptide mass fingerprinting,<br>protein interaction: genetic test, yeast 2-hybrid system, co-immunoprecipitation , Affinity chromatography, FRET, SPR | 6 |
| UNIT 8 | **Scope, prospects and challenges of Proteomic studies**<br>High Throughput protein functional analysis; Target discovery, interaction proteomics, Chemical Proteomics<br>**Application of Proteomic**<br>Application of Proteomic in Gene Expression, Protein discovery, Biomarker discovery, therapeutic management of disease<br>Challenges in proteomics | 6 |

**MODE OF ASSESSMENT:**

a) Internal written exam
b) Group Discussion
c) Quiz
d) Seminar

**EXPECTED LEARNING OUTCOME:**

The students will

a. learn how genomics and proteomics application in biological research can benefit in solving the complex biological and biochemical processes regardless of the type of organism which is the model for them.
b. about the genomic constitution of prokaryotic and eukaryotic
c. have a firm underpinning of contemporary genome analysis techniques
d. have a thorough understanding of contemporary genome sequencing principle and working methodology.
e. have a lucid understanding of the various regular, contemporary and high throughput proteomic tools, their underlying principles and varied application.
f. have a comprehensive understanding of protein sequencing and identification techniques and explore its myriad scope and applications

**RECOMMENDED READINGS**


1. Alberts, B., Bray, D., Levis, J., Raff, M., Roberts, K., Watson, J.D. (1994) Molecular Biology of the Cell, Garland Publishing, New York. 5 NCBI web page Kellner R., Lottspeich F, Meyer H.E. 1999
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
4. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.
6. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
7. Micro-characterization of Proteins, WILEY-VCH second edition
8. Schägger H. 2006 Tricine-SDS-PAGE, Nature Protocols Vol. 1. No.1 16-22 Wittig I., Braun H.-P.
9. Schägger H. 2006 Blue native PAGE, Nature Protocols Vol. 1. No.1 418-428. E. De Hoffman, V.
10. Stroobant, 2002 Mass Spectrometry Principle and Applications, Wiley, Chichester, 239- 275. A. J. R. Heck, R. H.H. van den Heuvel, 2004 Mass Spectrom
11. Bengt Nolting 2004 Methods in modern Biophysics. Springer-verlag

**NAME OF THE COURSE:** **IMMUNOLOGY**
**COURSE CODE:** **CC-302**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**

1. To conceptualize how the innate and adaptive immune responses coordinate to fight invading pathogens.
2. To have an in-depth understanding of different diseases which result from genetic or congenital defects of immune system components
3. To develop skills, through lab experiments and exercises, in specific cell culture assays and imaging techniques for detection and quantification of immune responses.

**TOTAL CREDIT ASSIGNED:** **4**
**TOTAL MARKS:** **100**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | Types of immunity: innate and acquired immunity, active and passive immunity, concept of herd immunity, humoral and cell-mediated immunity. Cells and organs involved in immunity. Cell mediated effector responses. Leucocyte and macrophage migration and inflammation. Complement system: Activation pathway and its biological consequences, structure and function of MHC I and MHC II molecules, hypersensitivity reactions, immune suppression and immune tolerance. Autoimmune disorders, Immunodeficiency | 12 |
| 2 | Immunoglobulins: Structure, classes and functions, significance of Fab, Fc and hypervariable regions, allotypic and idiotypic variations. Catalytic antibodies. T Cell and B Cell generation and differentiation, activation and suppression. Multigene organization of Ig and TCR genes, rearrangement of DNA and generation of Ig and TCR diversity, Ig class switching, Diversity in other Immune molecules- Natural Killer cell Receptors and MHC molecules | 12 |
| 3 | Antigens: Characteristics, antigenicity and immunogenicity. Factors affecting immunogenicity, epitopes, haptens, processing and presentation of antigens, Role and properties of adjuvants, Immune modulators; B & T cell epitopes; Antigen – Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; Antigen processing pathways, Superantigens; Antibody production by hybridoma technology; Antibody engineering; Phage display libraries; Antibodies as in vitro and in vivo probes | 8 |
| 4 | Immuno assays RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, vaccine technology | 6 |

| | | |
|---|---|---|
| 5 | Identification of immune Cells; Principle of Immunofluorescence Microscopy, Cell Functional Assays – lymphoproliferation, mixed lymphocyte reaction, Apoptosis, Cytokine expression; Cell imaging Techniques | 8 |
| 6 | Transplantation, Clinical manifestations of graft vs host interaction, Tumor immunology, Passive Immunization: Antibody, Transfusion of immuno-competent cells, Stem cell therapy | 6 |

**MODE OF ASSESSMENT:**

a) Internal written exam
b) Group Discussion
c) Quiz
d) Seminar

**RECOMMENDED READINGS:**

1. Immunology, Kuby et al, W. H. Freeman, 2013

2. Essential Immunology, Roitt et al, Wiley-Blackwell, April 2011

3. Janeway's Immunology, Kenneth Murphy, Casey Weaver, March 2016

**NAME OF THE COURSE:** **GENETIC ENGINEERING**
**COURSE CODE:** **CC-303**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**

To gain a comprehensive understanding of the principles underlying the various techniques used in genetic engineering

To discern the principles underlying molecular cloning and gain indepth knowledge of various cloning vectors

To conceptualize the principles underlying DNA amplification and analysis

To gain an understanding of RNA technology and their applications in genetic engineering

**CREDIT POINTS: 4**
**TOTAL MARKS: 100**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | Introduction to Genetic engineering & rDNA Technology: Definition, history and scope. Molecular Genetic Tools: Restriction enzymes and their types (I, II, III), mode of action, cohesive and blunt end restriction, isoschizomers, restriction mapping, modification of DNA ends, (terminal transferases, linkers and adaptors). Ligases, T4 kinase, alkaline phosphatase, klenow fragment, Dnase-I, single strand specific nucleases, RNase H, Transformation in bacteria, animal and plant cells. | 8 |
| 2 | Gene cloning vestors: Plasmid vectors- nature and properties, isolation and purification of plasmid DNA, construction of plasmids, pUC and Bluescript vectors. Bacteriophage vectors- Lambda bacteriophage DNA, artificial packaging of lambda phage, replacement and insertional vectors. Cosmids, Phagemids-single stranded bacteriophage, M13 vectors, pEMBL vector and their use, Expression vectors. Animal Virus derived vectors-SV40, vaccine/bacculo & retroviral vectors, Baculovirus and pichia vectors; Plant based vectors, Ti and Ri as vectors, shuttle vectors. High capacity vectors: Yeast Artificial Chromosome (YAC), Bacterial Artificial Chromosome (BAC) and P1 Artificial Chromosome (PAC). | 8 |
| 3 | Cloning methodologies: Genomic DNA and cDNA library, cDNA and genomic cloning, Rapid Amplification of cDNA cloning (RACE), Expression cloning, Okayama and Berg method of cDNA cloning, Principles in maximizing gene expression. | 8 |
| 4 | Molecular techniques I: Southern, Northern, Western, Far-western, South-Western hybridization, Fluorescence in situ hybridization, DNA-Protein Interactions- Electromobility shift assay, chromosome walking and jumping, Gel Retardation Assay (GRA), Basic concept of microarray technology and transcriptome analysis, yeast two hybrid system, Hybrid released and Hybrid arrested translation. | 8 |

| | | |
|---|---|---|
| 5 | Primer designing; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, hot start PCR, colony PCR, cloning of PCR products; Site specific mutagenesis; PCR in molecular diagnostics;<br>Nucleic acid sequencing: Enzymatic DNA sequencing, chemical sequencing of DNA, RNA sequencing, Chemical synthesis of oligonucleotides | 8 |
| 6 | RNA technology- Heterogenous nuclear RNA (micro RNA, guide RNA, riboswitch), Introduction to siRNA technology. Principles of Gene Therapy; Gene splicing techniques, Transgenics; | 8 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

At the end of the course, students will be able to

1. Understand the fundamental molecular tools and their applications in DNA modification, manipulation and cloning.
2. Interpret knowledge of a defined skill set of basic molecular biology and biotechnology concepts, including PCR, DNA isolation, manipulation, cloning, DNA sequencing
3. Relate the conventional and molecular methods for gene manipulation in microbial and other systems, their problems and limitations
4. Recommend strategies of genetic engineering for possible application in Biotechnology and allied industry

**RECOMMENDED READINGS:**

1. Principles of Gene Manipulation, S.B. Primrose, R. M. Twyman and R. W. Old, 6th Edition, S.B. University Press, 2001
2. Genomes, T. A. Brown, 3rd edition, Garland Science, 2006
3. Molecular Cloning: A Laboratory Manual, J. Sambrook and D.W. Russel; Vol.s 1-3, CSHL, 2001.

**NAME OF THE COURSE:** **BIO PROGRAMMING WITH C**
**COURSE CODE:** **CC-304**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**

The objective of the course is

1) To provide complete knowledge of C language. Students will be able to develop logics which will help them to create programs, applications in C. Also by learning the basic programming constructs they can easily switch over to any other language in future.
2) Enable learner to to devise algorithms and approaches to tackle biological problems.
3) To provide a grounding in program design and implementation, programming environments and introduce practical exercises in writing bioinformatics software using a C programming language.

**CREDIT POINTS: 4**
**TOTAL MARKS: 100**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | **Introduction to Programming:** Application of Programming in Biotechnology and Bioinformatics, Program Logic and Design Techniques (Flowchart, Pseudo code); Solving Bio-Problems using Flowcharts and Pseudo codes | 8 |
| UNIT 2 | **Overview Of C**: C Tokens, Constants and Variables, Data Types, Operators and Expression, Managing input and output operations, Decision making and branching, Decision Making and Looping, | 10 |
| UNIT 3 | **Arrays.:** Character Array and Strings, Declaring and Initializing String Variables, String Handling Functions | 6 |
| UNIT 4 | **Pointers** Understanding pointers, Accessing array elements using pointers, Chain of Pointers, Pointer Expressions, Pointer and Character Strings, Array of Pointers. | 6 |
| UNIT 5 | **Dynamic Memory Allocation**:Introduction to Dynamic Memory Allocation | 4 |
| UNIT 6 | **File Handling:** Defining and Opening a File, Input/output operations on Files, Error Handling during I/O Operations, Closing a file. Concept of Text and Binary Files. Working with FASTA and PDB file formats | 6 |
| UNIT 7 | **Structure And Union** Defining structure, Structure within Structure, Array of structures, Structures and Pointers, Unions | 6 |
| UNIT 8 | **Functions:** Function Types, function Call (Call By Value, Call By Reference), Nesting of Functions, Recursion; Passing Arrays to Functions, Passing Strings to Functions, passing structures to functions. | 6 |

**MODE OF ASSESSMENT:**

a) Internal written exam
b) Group Discussion
c) Quiz
d) Seminar

**EXPECTED LEARNING OUTCOME:**

1. After successful completion of course learner will be able to develop basic bioinformatics tools and applications.

**RECOMMENDED READINGS:**

1. E.Balaguruswamy . Programming In ANSI C, 6th Edition 2012 Tata McGraw HilL
2. Byron Gottfried . PROGRAMMING WITH C, 3rd Edition 2010, Mcgraw Hill Education
3. Yaswant Karnetkar. Let Us C, 13th Edition 2012, BPB Publication
**4.** Yaswant Karnetkar. Data Structure Using C, 2nd Edition 2003 BPB Publications;

**NAME OF THE COURSE:** **LAB III**
**COURSE CODE:** **CC-305**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**
**TOTAL CREDIT ASSIGNED:** **3**
**MARKS:** **75**
**DISTRIBUTION OF CREDITS :** **L-0 T-0 P-3**

**List of practicals:**

**Genomics and Proteomics:**

1. Isolation of Genome sequence of Bacteria, mitochondria and viruses
2. Isolation of protein coding sequence of Bacteria, mitochondria and viruses
3. Protein purification and Separation: Native/SDS- PAGE
4. Protein estimation: Bradford's Assay
5. Protein estimination: Lowry's Method.

**Immunology:**

1. Determination of blood group in human.
2. Radial Immuno diffusion to study antigen antibody interaction.
3. Demonstration of agglutination inhibition using Latex beads
4. ELISA
5. Immunoelectrophoresis

**Genetic Engineering**

1. Isolation of genomic DNA from bacteria, plant and animal tissues
2. Isolation of plasmid DNA from bacteria
3. Qualitative analysis of the isolated DNA
4. Restriction digestion
5. Agarose Gel Electrophoresis
6. Polymerase Chain Reaction
7. RFLP
8. Random Amplification of Polymorphic DNA
9. Preparation of competent cells and transformation experiments

**Bioprogramming with C**

**1. Constructs**

Programs to use if-else, nested if-else, switch-case constructs , Programs to test looping constructs for, while and do-while (sum of n numbers, max of n numbers, fibonacci series, amstrong number, prime number) , Programs to test nested loops(preferably number pyramids,); Program to test use arrays single dimensional, multi dimensional(3x3 matrix); Sum of series similar to X+X^2+X^3+...+x^n where x and n are given by user.

**2. Structures & pointers**

Programs to use structure and loops, structure and pointers, array of structures; Programs to use

pointers, pointer-to-pointer, pointer to arrays, pointer to structures.

**3. Functions**

Programs to test Functions (all 5 types), recursive functions, test call by value and call by reference

**4. File Handling**

Program to handle file i/o

**5. Dynamic memory allocation and linked List**

Program to use malloc, calloc, realloc and free;

**6. Searching and Sorting:**

Sort a list of given numbers; search a given element from an ordered and unordered list.

**7. Bio Programs :**

Find complementary and reverse complementary of a given DNA sequence; Find RE sites in a given DNA sequence for a given restriction enzyme; Find the GC% content of a given DNA sequence; transcribe a DNA sequence to RNA sequence; translate an mrna sequence to protein.

**NAME OF THE COURSE:** **DBMS III (PHP/MySQL)**
**COURSE CODE:** **DSE(T)-301**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**

The objective of the course is

1) To enable learner to understand basics of server side applications and to enable the to set environment for development
2) To enable learners to understand PHP Programming to enable them to integrate PHP Scripts with HTML front end
3) To enable learners to work with files, sessions and cookies
4) To enable the learner to store and retrieve data from MySQL database using PHP scripts

**TOTAL CREDIT ASSIGNED:** **3**
**MARKS:** **75**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Introducing PHP and MySQL, Server-Side Applications and the Databases Setting Up a PHP-MySQL Development Environment | 6 |
| UNIT 2 | PHP Variables, Statements, and Operators, Using Conditional Statements and Loops | 8 |
| UNIT 3 | Forms: Form Handling and Validation | 5 |
| UNIT 4 | Arrays and Custom Functions | 7 |
| UNIT 5 | Using Files (Open/Read, Create/Write, Upload), Sessions, Cookies, and External Programs | 7 |
| UNIT 6 | PHP-MySQL Connectivity: Connect, Create DB/Table, Select/Insert/Update/Delete Data | 8 |

**MODE OF ASSESSMENT:**

a) Internal written exam
b) Group Discussion
c) Quiz
d) Seminar

**EXPECTED LEARNING OUTCOME:**

After successful completion of course learner will be able

Develop web application using server side PHP programming and Database Connectivity using MySQL.

**RECOMMENDED READINGS:**


1. Powell Thomas. HTML & CSS: The Complete Reference, Fifth Edition. Mcgraw Hill
2. Steven Holzner. PHP: The Complete Reference 2017 McGraw Hill Education
3. Luke WellingLaura Thomson. PHP and MySQL Web Development. Pearson 5th Edition 2016
4. Vikram Vaswani, How to do everything with PHP and MySQL, MacGrawHill 2005

**NAME OF THE COURSE:** **PLANT BIOTECHNOLOGY- III**
**COURSE CODE:** **DSE(T)-302**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**

1. This subject aims to introduce students to the techniques of genetic engineering in reference to plants, and further extensive studies on genetically modified plants.
2. The course will also impart knowledge on basic Mendelian genetics tenets which apply to plants, and their use in breeding.
3. Students will also learn about the biotechnological improvements of plants and their application in industrial agriculture, as well as be apprised of the plant biosafety guidelines which have been put in place to safeguard the indigenous flora of a region.

**TOTAL CREDIT ASSIGNED:** **3**
**MARKS:** **75**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | Techniques of Genetic engineering of plants: microbial vectors, microprojectile bombardment, Microinjection, electroporation, transposons. Marker-assisted selection | 7 |
| 2 | Mendelian genetics and plant reproduction: Demonstration of Mendel's in plants, Deviation from Mendel's laws- examples in plants, Plant reproductive biology, Plant breeding techniques | 7 |
| 3 | GM crops, Identifying genes of interest in Transgenic plants, Advantages and disadvantages of GM crops, International and national laws governing GM crops | 7 |
| 4 | Transgenic plant analysis: Initial Screens for Putative Transgenic Plants, Molecular characterization of transgenic plants, Digital imaging and phenotypic analysis of transgenic plants | 7 |
| 5 | Plant Biosafety Levels and Facilities, Biocontainment, Regulatory bodies of GM crops research in India, Intellectual Property and Bioethics in Relation to Agricultural Research | 5 |
| 6 | Controlling plant response to the environment- biotic and abiotic stress, Biotechnological improvements of yield and quality traits, Plants as factories for industrial products, pharmaceuticals and biomaterials, Plants and crop residues for bioenergy | 7 |

**DSE(P) – 302 PRACTICAL (1 CREDIT)**

| | |
|---|---|
| **NAME OF THE COURSE:** | **Lab Course on DSE(T) - 303** |
| **COURSE CODE:** | **DSE(P)- 302** |
| **CREDIT:** | **1** |
| **MARKS:** | **25** |
| **DISTRIBUTION OF CREDIT:** | **L-0 T-0 P-1** |

- DNA extraction of selected plants
- PCR-based techniques for analysis of plant species
- Transformation of plants and selection of transformants
- Tissue culture of plant species essential for bio fuel

**RECOMMENDED READINGS:**


1. Plant Tissue Culture: Theory and Practice. S.S. Bhojwani, M.K. Razdan, Elsevier, November 1996
2. Plant Tissue Culture Techniques and Experiments. Roberta H. Smith. Academic Press; 3rd edition (August 3, 2012)
3. Plants from Test tubes- An Introduction to Micropropagation. Holly Scoggins and Mark Bridgen. Timber Press; Fourth Edition, Revised edition (August 13, 2013)
4. Plant Biotechnology: The Genetic Manipulation of Plants. Slater, Scott, Fowler. Oxford University Press; 2 edition (June 2, 2008)
5. Introduction to Plant Biotechnology. H.S. Chawla. CRC Press, 2009

**NAME OF THE COURSE:** **APPLIED MICROBIOLOGY-III (FOOD MICROBIOLOGY)**
**COURSE CODE:** **DSE(T)-303**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**
Upon completion of this course, students are expected to be able to:

- Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods.
- Understand the role and significance of intrinsic and extrinsic factors on growth and response of microorganisms in foods.
- Identify ways to control microorganisms in foods.
- Describe the beneficial role of microorganisms in fermented foods and in food processing.
- Utilize laboratory techniques to detect, quantify, and identify microorganisms in foods.

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | History and development of Food microbiology: History of Microorganisms in Food-developments: Common Food borne Bacteria, Molds Role, and Significance of Microorganisms in Foods.Parameters Affecting Microbial Growth: Intrinsic, Extrinsic.Combined Intrinsic and Extrinsic Parameters-lactic antagonism and hurdle concept. | 6 |
| UNIT 2 | Microorganisms in Foods and methods for detection: Fresh meat,Processed meat and poultry, Culture, Microscopic, and Sampling Method for detecting microbes, Physical, Chemical methods,Whole animal assays, Immunological methods. | 6 |
| UNIT 3 | Food Preservation & Principles of Quality Control: Chemicals antibiotics,Radiation,Low and high temperature, High-Pressure Processing Pulsed Electric Fields .Aseptic Packaging ,Manothermosonication, Microbiological quality standards of food, FDA, HACCP, ISI. | 6 |
| UNIT 4 | Microbial Food Spoilage and Food borne diseases: Staphylococcal, Ecoli, Salmonellosis, shigellosis, Listerial infections. Mycotoxins, Aflatoxins Alternaria Toxins, Toxigenic Phytoplanktons and viruses. | 6 |
| UNIT 5 | Applications of Food Microbiology: Beneficial Uses of Microorganisms in Food Intestinal Beneficial Bacteria-Concept of Prebiotics and Probiotics, Genetically modified foods. Biosensors in food | 6 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

Upon successful completion of the course, students should be able to:

- Explain the interactions between microorganisms and the food environment, and factors influencing their growth and survival.
- Explain the significance and activities of microorganisms in food.
- Describe the characteristics of foodborne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification.
- Explain why microbiological quality control programmes are necessary in food production.
- Explain the effects of fermentation in food production and how it influences the microbiological quality and status of the food product.
- Discuss the microbiology of different types of food commodities
- Discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food.

**NAME OF THE COURSE:** **Lab Course on DSE(T) - 303**
**COURSE CODE:** **DSE(P)- 303**
**CREDIT:** **1**
**MARKS:** **25**
**DISTRIBUTION OF CREDIT:** **L-0 T-0 P-1**

**List of practical:**

1. Microbial analysis of spoiled dairy products
2. Antibiotic sensitivity assay of microbes
3. Replica plating method
4. Ames test for the identification of mutants
5. Extraction and characterization of microbial endo and exo toxins
6. Quality control techniques

**RECOMMENDED READINGS:**

1. Greenwood D (2007). Medical Microbiology. I.K. International.
2. Murray PR, Pfaller MA, Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press.
3. Talaro KP and Talaro A. (2006). Foundations in Microbiology. McGraw-Hill College Dimensi.
4. Willey J, Sherwood L. and Woolverton C (2007). Prescott/Harley/Klein's Microbiology, McGraw Hill.
5. Atlas RM (1997). Principles of Microbiology. McGraw Hill.
6. Nester E.W, Anderson DG and Nester MT (2006). Microbiology. A Human Perspective. McGraw Hill.
7. Harvey, R.A., Champe, P.C. and Fisher, B.D. 2007. Lippincott’s Illustrated Reviews : Microbiology. Lippincott Williams and Wilkins, New Delhi/New York.

**NAME OF THE COURSE:** **BIOCHEMISTRY- III (BIOENERGETICS AND METABOLISM)**
**COURSE CODE:** **DSE(T)-304**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES**

The course is designed to provide an insight into biochemical reactions and metabolic pathways with emphasis on their regulation and integration.

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| Unit | Contents | Contact Hours |
|---|---|---|
| **1** | **Bioenergetics:** Concept of free energy. High energy phosphate compounds, free energy of hydrolysis of ATP | **6** |
| **2** | **Coenzymes and Cofactors:** Roles and mechanism of action of coenzymes and cofactors like- $NAD^+$ /$NADP^+$ , FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions | **7** |
| **3** | **Carbohydrates:** Glycolysis- pathway, regulation & energetics, citric acid cycle- reactions, regulation & energetics, pentose phosphate pathway-significance. Gluconeogenesis, glycogenesis and glycogenolysis, Cori cycle, anaplerotic reactions. Hormonal regulation of carbohydrate metabolism. | **8** |
| **4** | **Amino Acids:** General reactions of amino acid metabolism - transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids. Urea cycle and its regulation. | **6** |
| **5** | **Lipids:** Hydrolysis of tri-acylglycerols, α-, β-, ω- oxidation of fatty acids. | **4** |
| **6** | **Nucleotides:** Metabolism of purines and pyrimidines- reactions and regulation | **5** |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

At the end of the course, the student is anticipated to develop an appreciation of biochemical pathways and understand their significance in the sustenance of life.

**NAME OF THE COURSE:** **Lab Course on DSE(T) - 304**
**COURSE CODE:** **DSE(P)- 304**
**CREDIT:** **1**
**MARKS:** **25**
**DISTRIBUTION OF CREDIT:** **L-0 T-0 P-1**

Laboratory exercises will be designed based on the course content.
A tentative list is provided below:

1. Extraction of enzymes from microbial/ animal/plant tissues/ organs.
2. Assays for enzyme activity
3. Study of the effect of inhibitors/ enhancers on enzyme catalysed reactions.
4. Protein purification

**RECOMMENDED READINGS:**


- Berg J.M., TymoczkoJ.L., Stryer L. Biochemia. PWN Warszawa 2007
- Nelson DL and MM Cox. Lehninger Principles of Biochemistry (5th edition). ("Lehninger")
- Loertscher J and V Minderhout. Foundations of Biochemistry (3rd edition). ("FOBC")
- Moran, Horton, Scrimgeour, & Perry. Principles of Biochemistry, 5th Edition, Pearson Publishing © 2011
- Murray R.K., Granner D.K., Mayes P.A., Rodwell V.W. Harper's Illustrated Biochemistry. Lange Medical Books 2003

**NAME OF THE COURSE:** **INTEGRATIVE BIOLOGY III: OMICS AND SYSTEM BIOLOGY**
**COURSE CODE:** **DSE(T)-305**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVES:**

This course gives a hands-on introduction to the part of systems Biology. The course will give the student knowledge about network Biology,

It would be expected that after completing this course a student would:

1. critically comprehend the ontologies associated with Genes at various functional and molecular level
2. strong foundation in basic graph theory and networks.
3. have a understand the foundation and application of various molecular methods using biological sequence information to study genetic variation within and between speciesexplain and justify different models of bioprocess

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | **Graph Theory and Networks**<br>Definition of graphs, Vertices and edges<br>Various types of graphs: simple graphs, multi graphs pseudographs, complete graphs, null graphs, bipartite graphs, complete graphs, regular and cubic graphs, digraphs<br>Isolated point, Directed and undirected graphs<br>Paths,cycle, | 7 |
| **2** | **Network analysis**<br>Comprehension and inference of key network parameters Network topology and parameters: Degree, betweenness and centrality, Scoring of interactions, Theorems in networks.<br>Numerical Representation of a Graph | 7 |
| 3 | **Gene function and Ontology**<br>Need for association of function with gene, Functional Genomics.<br>Aim and objectives of GO, levels of GO for gene products.<br>Classification of GO terms; Understanding and application of under and over representation of GO terms | 7 |
| **4** | **Vizualization, analysis and inference of Bionetworks**<br>Proteomics, transcriptomics and metabolomics of bacterial systems. Omic data to gain understanding of the biochemistry of a gene regulatory system; Introduction to core components of metabolic regulation, Visualization regulatory networks.; Using pathways and network information to understand metabolic processes. Navigate in the KEGG and NCBI databases and extract relevant information. | 6 |

| | | |
|---|---|---|
| **5** | **Networks in Biology**<br>GO study through networks; Yeast protein interaction network– A case study; Interconnectedness of Molecular Machinery Underlying Diseases Networks in pharmacology | 6 |
| **6** | **Interconnectedness of Evolutionary and System Biology**<br>genome wide association studies (GWAS); Databases and webservers for network studies; Drug protein interaction; Evolutionary model of transcription regulation | 6 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discussion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

A student who has met the objectives of the course will be able to:

1. Apply basic graph-theory based measurements on biological networks.
2. Describe basic computational methods for reconstructing and scoring biological networks based on high-throughput data.
3. Use the network visualization/analysis software for integrative network based analysis.
4. Critically assess the quality of high-throughput protein-protein interaction data.
5. Retrieve information from the Biological databases
6. Describe how fluctuations in metabolite pool sizes can affect gene expression profiles.

**NAME OF THE COURSE:** **Lab Course on DSE(T) - 305**
**COURSE CODE:** **DSE(P)- 305**
**CREDIT:** **1**
**MARKS:** **25**
**DISTRIBUTION OF CREDIT:** **L-0 T-0 P-1**

1. Creating your own network.
2. Sketching the Biological pathway.
3. GO identification of protein cluster
4. Construction of network map using GO terms
5. Working with Bio-network tool
6. Creating your first circular association map

**RECOMMENDED READINGS:**


1. Fundamantals of biochemistry ( 3rd Edition ) by D., voet, J.G.& Pratt, C.W. John wiley & Sons.
2. Lehninger principles of biochemistry ( $5^{th}$ Edition) by D. L. Nelson & M.M.Cox, W.H. freeman & Co.
3. Principles of biochemistry ( $4^{th}$ Edition) By H. R. Horton, L.A. Moran, K.G. scrimgeour, M. D. Perry & J.D.Rawn, pearson-prentice Hall.
4. Biochemistry ( $6^{th}$ Edition) by J.M. berg, J.L. Tymoczko & L. Stryer, W. H. Freeman & Co.

5. Metabolomics: methods and Protocols (methods in molecular Biology) by Wolfram weckwerth.
6. The Handbook of metabonomics and metabolomics by John C. Lindon, jeremy K. Nicholson, and elaine holmes.
7. Metabolomics, metabonomics and metabolite Profiling (RSC biomolecular sciences) by W. Griffiths.
8. Goeh et al., (2007). The human disease network. PNAS 104(21), pp. 8685-8690
9. Barabasi et al, "Network Medicine: A network based approach to human disease", Nature Reviews (2002)

**NAME OF THE COURSE:** **DRUG DISCOVERY – III (ADVANCED COMPUTER AIDED DRUG DESIGN)**
**COURSE CODE:** **DSE(T)-306**
**COURSE TYPE:** **DISCIPLINE SPECIFIC ELECTIVE (DSE)**
**DISTRIBUTION OF CREDIT:** **L -3 T-0 P-1**

**COURSE OBJECTIVE:**

The course will enable the students to effectively use databases pertaining to Computer Aided Drug Design, to understand De Novo drug design techniques, to understand Pharmacophore Mapping, and to have expertise in molecular docking and molecular dynamics. Upon completion of this course the student should be able to:

1. Effectively use databases pertaining to Computer Aided Drug Designing
2. Understand De Novo drug design techniques
3. Understand Pharmacophore Mapping
4. Gain expertise in molecular docking and molecular dynamics

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| Unit I | Library and Database:<br>Molecular and Structural Database, Protein Data Bank, Bioactivity Databases, Gene and Protein Sequence Databases, Cambridge Crystallographic Database, Compound Storage and Management. | 5 |
| UNIT 2 | De Novo Drug Design Techniques:<br>Receptor/enzyme cavity size prediction, Predicting the functional components of cavities, designing drugs fitting into cavity | 7 |
| UNIT 3 | Pharmacophore:<br>Concept, Pharmacophore mapping, Hypothesis Generation, Reverse Pharmacophore mapping. | 7 |
| UNIT 4 | Docking studies:<br>Molecular docking, Rigid docking, Flexible docking, Manual docking, Advantage and disadvantage of Flex-X, Flex-S, AUTODOCK and other docking software, Scoring Functions, Simple Interaction Energies, GB/SA scoring (implicit solvation), CScore (consensus scoring algorithms). | 8 |
| UNIT 5 | Molecular Dynamics:<br>Concept, objectives and terms in Molecular Dynamics, Molecular Interactions, MD Algorithm, Molecular Dynamics in Different Ensembles, Density Functional Theory, Linear Scaling Techniques, *Ab initio* Methods and Hartree-Fock Approximations. | 8 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discussion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

- After successful completion of the course learner is expected to have knowledge in Library and Database, De Novo Drug Design Techniques, Pharmacophore, Molecular docking and Molecular dynamics studies

**NAME OF THE COURSE:** **Lab Course on DSE(T) - 306**
**COURSE CODE:** **DSE(P)- 306**
**CREDIT:** **1**
**MARKS:** **25**
**DISTRIBUTION OF CREDIT:** **L-0 T-0 P-1**

- Drug design by computational technique
- Energy minimization for stable conformation
- Prediction of structure of a protein molecule using Homology modelling
- Drug design using principle of Pharmacophore mapping and Docking
- Study of drug-receptor interaction using docking studies
- Calculate of absorption and distribution rate of a drug
- Prediction of toxicity of drug molecule using *in- silico* approaches
- Study of molecular dynamics simulation

**RECOMMENDED READINGS:**


- Ahindra Nag and Baishakhi Dey; Computer-Aided Drug Design and Delivery Systems; McGraw-Hill Education; edition 2010
- D. C. Rapaport; The Art of Molecular Dynamics Simulation, 2nd Edition; Cambridge University Press; 2 edition 2004
- Andrew Leach; Molecular Modelling: Principles and Applications (2nd Edition) ; Pearson; 2001

**NAME OF THE COURSE:** **RESEARCH METHODOLOGY**
**COURSE CODE:** **AEC - 301**
**COURSE TYPE:** **ABILITY ENHANCEMENT COURSES (AEC)**
**DISTRIBUTION OF CREDIT:** **L -2 T-0 P-0**

**COURSE OBJECTIVES:**

1. The objective of the course is to familiarize the learners with the concepts, approaches and methodology used in research.

**CREDIT POINTS: 2**
**TOTAL MARKS: 50**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| Unit I | Fundamentals of Technical Aptitude: This unit will focus on the fundamental knowledge on technical terminologies for a research agenda in Life Sciences include definition of problem, reasoning, hypothesis, thesis, synopsis and research; selection of research problem; writing synopsis, thesis, other technical communications, and presentation of technical communications. | 10 |
| UNIT 2 | Methods and techniques of collection, preparation and preservation of plant, animal, soil and water samples. | 10 |
| UNIT 3 | Instrumentation: common instruments used in biological research, their operational principles and maintenance. | 8 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discussion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

- After successful completion of course learner will be able to conduct research in structured manner.

**RECOMMENDED READING:**


1. CR Kothari; Research methodology: methods and techniques; New Age International Publishers.
2. Kumar; Research Methodology; A step by step guide for beginners. 2nd Edn. 2005. Pearson Publishers.

**NAME OF THE COURSE:** **IN VITRO CELL CULTURE TECHNIQUES**
**COURSE CODE:** **GE(T)-301**
**COURSE TYPE:** **GENERAL ELECTIVE**
**COURSE STRUCTURE:** **L3-T0-P0**

**COURSE OBJECTIVES:**

1. This subject aims to introduce students to Animal Cell Culture techniques and apprise them of basic concepts in the same, as well as advances which have led to the commercialization of products derived from cell cultures.
2. This course would help students to also train in the basic culture techniques required for the culture and also preservation of animal cells.
3. The students will also learn about the scientific concepts and importance of stem cell research and the breakthroughs that will shape the future of medical-related applications of the same.

**CREDIT POINTS: 3**
**TOTAL MARKS: 75**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | Basic techniques of animal cell culture: types of cell cultures, Isolation and maintenance of animal cell culture, cryopreservation techniques, methods of characterization and cross validation. | 5 |
| 2 | Cytotoxicity, Culture of Specific Cell Types, Culture of Tumor Cells, Organotypic Culture, Scale-Up, Germplasm conservation techniques for animal species | 5 |
| 3 | Applications of animal cell culture: *in vitro* fertilization and culture of embryos, Vaccine production, Monoclonal Antibody production, Production of recombinant proteins | 5 |
| 4 | Concepts on stem cells and historical perspectives, Cellular and molecular features of stem cells, Derivation, differentiation and propagation of stem cells, Germline stem cells and germline-derived pluripotent cells | 5 |
| 5 | Different stem cells: Embryonic Stem cells; Induced pluripotent stem cells & direct differentiation; Hematopoietic Stem cells, Prostate and Mammary Stem cells; Neuro stem cells, Mesenchymal SCs, Intestinal and skin stem cells, Cancer and stem cells, Advances and applications of Stem Cell Therapy, Ethical issues associated with stem cell biology and cell cultures | 6 |

**MODE OF ASSESSMENT:**

- Internal written exam
- Group Discussion
- Quiz
- Seminar

**NAME OF THE COURSE:** **IN VITRO CELL CULTURE TECHNIQUES**
**COURSE CODE:** **GE(P)-301**
**COURSE TYPE:** **GENERAL ELECTIVE**
**COURSE STRUCTURE:** **L0-T0-P1**

**CREDIT POINTS: 1**
**TOTAL MARKS: 25**

**COURSE CONTENT**

1. Operation and handling of equipments used in animal cell culture
2. Sterilisation of equipments and work area
3. Preparation of animal cell culture media
4. Passaging of cells
5. Cryopreservation of cells
6. Trypan blue exclusion assay
7. Cytotoxicity assay by MTT

**RECOMMENDED READINGS:**


1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, R. Ian Freshney, Sixth Edition, March 2011
2. Animal Cell Culture Techniques (Springer Lab Manuals). Martin Clynes. Springer. 1998
3. Animal Cell Culture and Technology. Michael Butler. Taylor & Francis; 2 edition (25 December 2003)
4. Animal Cell Culture: A Practical Approach. John Masters. OUP Oxford; 3 edition (29 June 2000)

## FORTH SEMESTER SYLLABUS

**NAME OF THE COURSE:** **BIOPROCESS ENGINEERING AND TECHNOLOGY**
**COURSE CODE:** **CC-401**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**

1. To gain a comprehensive understanding of the principles underlying the various techniques used in bioprocess engineering and technology

**CREDIT POINTS: 4**
**TOTAL MARKS: 100**

| UNIT | CONTENTS | HOURS |
|---|---|---|
| 1 | Basic principle of Biochemical engineering: Isolation screening and maintenance of industrially important microbes, microbial growth and death kinetics (particularly with reference to industrially useful microorganisms), strain improvement for increased yield and other desirable characteristics | 8 |
| 2 | Detailed study of the design and operation of different types of fermenters, Mode of fermentation processes: Bioreactor designs, types of fermentations and fermenters: Upstream processing: scale up and scale down process. | 8 |
| 3 | Fermentation process kinetics: Reaction kinetics: effect of temperature on reaction rate, thermal death of micro-organisms, enzyme inhibition, Fermentation kinetics: advantages and limitations, Downstream processing: Bioseparation: drying, crystallization, storage and packaging, treatment of effluent and its disposal | 8 |
| 4 | Applications of enzymes in food processing: enzymatic bioconversions *e.g*. starch and sugar conversion processes, High-Fructose Corn Syrup, and their downstream processing, backing by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing, cheese making by proteases. | 8 |
| 5 | Application of microbes in food process operations and production: Fermentated foods, producing colours and flavours, processing of wastes-whey, molasses, starch substrates and other food wastes bioconversion into useful products; Bacteriocins: production and applications. | 8 |
| 6 | Biodegradation of xenobiotic compounds and toxic wastes, removal of spilled oil & grease deposits, Biosurfactants, Bioremediation of soil & water, solid waste & waste water treatment, use of microorganism for the production of energy: Biogas (production of methane and hydrogen), fuel alcohol production & hydrocarbon production | 8 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

The students will be able to

- Describe the principle and applications of bioprocess technology.
- Apply fundamental calculation in bioprocessing.
- Illustrate the schematic diagram of upstream and downstream processing for product recovery and purification.
- Analyze the mass transfer and material balance calculation in different types of application in bioprocess.
- Analyze the kinetics parameter values in different types of fermentation modes.
- Discuss the important aspects in bioprocess technology for commercialization purpose of biotechnology products

**RECOMMENDED READINGS:**


1. Fermentation and Biochemical Engineering Handbook, Principles, Process Design, and Equipment; Edited by Henry C. Vogel; Noyes Publications, New Jersey, U.S.A. ISBN: 0-8 155-1407-7.
2. Biotechnology- Volume 3- Bioprocessing; VCH Verlagsgesellschaftmb H. Weinheim, ISBN 3-527-28313-7 (Weinheim); ISBN 1-56081-153-6 (New York).
3. Principles of Fermentation Technology, P. E. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heinemann, ISBN: 07506 45016.
4. Practical Fermentation Technology, B. Mcneil and L. M. Harvey, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, ISBN 978-0470-014349

**NAME OF THE COURSE:** **STRUCTURAL BIOLOGY**
**COURSE CODE:** **CC-402**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**

This course would train graduate students to become proficient and successful investigators who are able to demonstrate a basic knowledge of central concepts in the biomedical sciences. The students will:

1. gain insight into the current concepts in structural biology and biochemistry.
2. have a strong understanding of protein structure and associate function.
3. have a clear understanding of various technologies helping us in elucidation of structure biomolecules
4. have a basic understanding of various computational methods employed for structure biomolecules taking cues from experimental data
5. know about various online and offline databases and tools for retrival, processing and inferring of protein sequence and structure

**CREDIT POINTS: 4**
**TOTAL MARKS: 100**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | **Protein Structure**<br>Peptide bond, amino acids: Structures & nomenclature (one and three letter code), disulfide bridge, conformation , conformers, rotamers<br><br>**Introduction to Protein Structure**:<br>Levels of Protein Structure: Primary structure, Secondary Structure, Tertiary Structure, Quaternary Structure; | 6 |
| UNIT 2 | **Motifs in Protein Structure**<br>**Critical concepts in protein motifs**: Dipole moment of α helix; α helix destabilizing amino acid, Parallel and antiparallel β strands,<br><br>**Protein Structure 3 main classes**:<br>Alpha-domain Structures,<br>Alpha/Beta Structures,<br>Beta Structures,<br>Domain in Protein Structure; Conserved Domains in Proteins. | 7 |

| | | |
|---|---|---|
| UNIT 3 | **Folding and Flexibility**<br>**Ramachandaran map:**<br>Overview of Φ, Ω, Ψ chi angles in protein structures,<br>Evaluating and validating a model: Regions in Ramachandran map i.e. Core, allowed, Disallowed regions;<br>Why Glycine can adopt many different conformation | 6 |
| UNIT 4 | **Structure Determination (Experimental –I)**<br>**X-ray Diffraction**<br>Overview of Protein X-ray crystallography<br>Protein Crystallization: Crystallization Methods:- Crystallization by Hanging Drop Vapor Diffusion Method, Sitting Drop Vapor Diffusion Method, Sandwich Drop Vapor Diffusion, Free Interface Diffusion, Micro Seeding Method, Macro Seeding Method, Micro Dialysis Method, Micro Batch Method, other methods including High throughput Protein crystallization. Crystallization conditions and factors affecting Protein Crystal Properties<br><br>Data collection and analysis:<br>X-ray diffraction setup, radiation source, Detector Type,<br>Mathematical equations involved in X-ray Crystallography and their application including Bragg's law and Fourier and inverse Fourier transformation<br><br>Variation in Xray diffraction: Cryo-crystallography and time resolved crystallography;<br>Scope and limitations of X-ray crystallography | 7 |
| Unit 5 | **Structure Determination Experimental -II**<br><br>**Nuclear Magnetic Resonance (NMR)**<br>Principles and working of NMR:<br>Zeeman effect & Larmor precession, nuclear spin, NMR signal detection, free induction decay, Fourier transformation, chemical shift.<br>Types of NMR:<br>1D,2D,3D NMR, Spin-spin coupling, COSY, NOESSY<br>Introduction to Protein NMR<br>Sample preparation using recombinant methods, cell free production and labeling protocols for NMR-based structural proteomics.<br>Pros and Cons of NMR in structural biology | 7 |
| Unit 6 | **Structure Determination Experimental –III**<br><br>Electron microscopy ; Scanning Probe microscopy; Overview of ORD/CD | 7 |

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|---|---|---|
| Unit 7 | **Structure Determination (Theoretical –I)**<br>**In-silico methods**:<br>Overview of Algorithm for in silico protein structure prediction: ab initio, Rosetta, Threading, Comparative/ Homology Modeling.<br><br>**Structure analysis:**<br>Overview of Molecular mechanics & Molecular dynamics. | 6 |
| Unit 8 | **Structure Determination (Theoretical –II)**<br><br>**Protein Structure Visualization:**<br>webservers and standalones : Rasmol, Chime and Mage, PDB, Discovery Studio<br><br>**Protein Structure on world wide web:**<br>Overview of Vast and Blast,<br>Overview of Scop, CATH, TOPS, FSSP, DALI,<br>EXPASY webserver, Pfam, ProDom | 6 |

**MODE OF ASSESSMENT:**

- Assignments
- Internal written exam
- Group Discusssion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

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

- Understand and infer about structural and chemical biology of biomolecules.
- Comprehend the protein structure and associate function.
- clearly understand contemporary technologies and methodologies for identification of structural information and engineering protein of interest
- perform various computational operations for structural information of biomolecules

**RECOMMENDED READINGS:**


1. Thomas E Creighton, Proteins: Structure and Molecular Properties, W H Freeman and Company
2. Carl Branden & John Tooze, Introduction to Protein Structure, Garland Publication
3. Bengt Nolting, Methods in Modern Biophysics, Springer
4. Protein structure prediction: methods and protocols by Webster, D.M., Ed. Totowa Humana Press.
5. Molecular protein domains by Gimona, G. Cesareni,. & Yaffe, M. Sudol(EDS.), USA., Wiley-vch verlag gmbh & co., 3-527-30813-X.

6. Molecular modeling: basic principles and applications by Holtje, H.D. & Folkers, G., Weinheim, VCH.

7. Molecular Modeling: Basic Principles and application by Hans Dieter & Didier Rognan, Wiley VeH Gmbh and Co.KGA.

8. Principles of Protein X ray Crystallography by Jan Drenth (2nd Edition)

9. Bioinformatics for comparative proteomics, C.H. Wu, C.Chen, Springer, ISBN 978-1-60761-976-5

10. Proteome Bioinformatics, S. J. Hubbard, A. R. Jones, Springer, ISBN 978-1-60761-443-2

**NAME OF THE COURSE:** **BIO PROGRAMMING WITH JAVA**
**COURSE CODE:** **CC-403**
**COURSE TYPE:** **CORE COURSE**
**COURSE STRUCTURE:** **L4-T0-P1**

**COURSE OBJECTIVES:**

The objective of the course is:
This subject aims to introduce students to the Java programming language. Upon successful completion of this subject, the students should be able:

1. To write Java programs that leverage the object-oriented features of the Java language, such as encapsulation, inheritance and polymorphism;
2. To use data types, arrays and other data collections;
3. To implement error-handling techniques using exception handling
4. To create and event-driven GUI using Swing components
5. To implement I/O functionality to read from and write to text files.
6. To use Bio Java modules to efficiently develop advanced bioinformatics applications.

**CREDIT POINTS: 4**
**TOTAL MARKS: 100**

| UNITS | CONTENTS | HOURS |
|---|---|---|
| UNIT 1 | Overview of Java: Introduction to Java and its Environment Features of Java, Java Application Vs Applets, Java Architecture, Java Security Model, JDK and Tools in JDK | 7 |
| UNIT 2 | Java Laguage Basics: Java Language Tokens, Java Data Types, Operators in Java, Flow Controls in Java, Arrays | 8 |
| UNIT 3 | OOP in Java: OO design Class methods and access privileges, Implementing Inheritance, Polymorphism in Java | 5 |
| UNIT 4 | Packages and Interfaces: Introduction to packages, creating packages, Inheritance of Interfaces | 3 |
| UNIT 5 | Exception handling : Differentiate error and exception, Different types of exception<br>Catching and throwing exception, Creating Custom Exception. | 6 |
| UNIT 6 | File handling: input and output: Concepts of Streams in Java, Understanding File Operations, Reading from and Writing to files, various file handling functions | 8 |
| UNIT 7 | GUI design and implementation: Introduction to AWT and Swing, Frames and Applet, Layout managers<br>Event handling: Event Delegation Model, Event classes in Java, Writing a event driven program, Event Handling in GUI | 8 |
| UNIT 8 | Introduction to Bio Java: Introduction to Bio Java 4.2.2; Core Module - Working with Sequences( Pairwise and Multiple Sequence Alignment), Physico-Chemical Properties Computation of Protein Sequence, Working with Protein Structure , Remote Web Service Calls to NCBI. Building Java Applications for Bioinformatics | 7 |

**MODE OF ASSESSMENT:**

- Internal written exam
- Group Discussion
- Quiz
- Seminar

**EXPECTED LEARNING OUTCOME:**

- After successful completion of course learner will be able to develop advanced CUI/GUI based bioinformatics tools and applications.

**RECOMMENDED READINGS:**

1. E.Balaguruswamy. Programming with Java by Mc Graw Hill Education; 4 edition
2. Herbert Schildt. Java: A Beginner's Guide by, McGraw Hill; Sixth Edition (1 July 2014)
3. Herbert Schildt. Java: The Complete Reference by McGraw-Hill Education; 9 edition (April 1, 2014)
4. Deiteil and Deitiel. How to Program Java

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|---|---|
| **NAME OF THE COURSE:** | **LAB-IV** |
| **COURSE CODE:** | **CC-404** |
| **TOTAL CREDIT ASSIGNED:** | **3** |
| **MARKS:** | **75** |
| **DISTRIBUTION OF CREDITS :** | **L-0 T-0 P-3** |

**CONTENTS**

**BIOPROCESS ENGINEERING AND TECHNOLOGY**

1. Handling and operation of Bioreactor/Fermenter.
2. Isolation of screening of amylase producing soil bacteria.
3. Isolation of screening of cellulase producing bacteria.
4. Production of wine from grapes.
5. Production of wine from apple juice.
6. Production of sauerkraut.
7. Production of edible mushroom.
8. Immobilization of enzymes/seeds/microbes.
9. Gram staining of yeast.

**STRUCTURAL BIOLOGY**

1. Exploring Expasy webserver
2. Calculation of Isoelectric point of a protein sequences
3. Protein structure retrieval, visualization and drawing inference from molecular structure of protein using various standalones and plugins

**BIOPROGRAMMING WITH JAVA**

1. Class & objects:

Create a Class in Java to perform all arithmetic operations, create a class in Java with methods to accept and display records.

2. GUI Programming

Create a frame in Java to calculate melting temperature, write a GUI interface to accept records and store in a file, create an applet.

3. File Handling

Write a content in a text file and to read the same, to create a directory first and then create a file inside the directory and also write a given contents to the file

4. String Handling

Test various string handling functions, search a sub string in a string

5. Inheritance and Polymorphism, overloading, overriding

Write a program in Java To implement inheritance and multiple inheritance, multilevel inheritance, To test method overriding, To implement polymorphism ,method overloading and constructor overloading

6. Bio Programs:

Write Program in JAVA to (a)Find complementary and reverse complementary of a given DNA sequence; (b) Find the GC% content of a given DNA sequence; (c) melting temperature of a oligomer (Basic, Salt adjusted). (d) Find the Hydrophobicity of a given sequence of a protein (E) Find the net-charge of a given sequence of a protein. (f) Find the Hydrophobicity of a given sequence of a protein (g) Find the flexibility index of a given sequence of a protein

## PROJECT WORKS

**Course Code:** **DSE(PR) - 401**
**Course Title:** **DBMS IV (Project Work)**
**Nature of the Course :** **DSE**
**Total Credit Assigned :** **4**
**Total Marks :** **100**
**Distribution of Credit:** **L-0 T-0 P-4**

**Contents:**

Project work on Biological Database Design and Development

**Course Code:** **DSE(PR) - 402**
**Course Title:** **Plant Biotechnology – IV (Project Work)**
**Nature of the Course :** **DSE**
**Total Credit Assigned :** **4**
**Total Marks :** **100**
**Distribution of Credit:** **L-0 T-0 P-4**

**Contents:**

Project work on Plant Biotechnology

**Course Code:** **DSE(PR) - 403**
**Course Title:** **Applied Microbiology – IV (Project Work)**
**Nature of the Course :** **DSE**
**Total Credit Assigned :** **4**
**Total Marks :** **100**
**Distribution of Credit:** **L-0 T-0 P-4**

**Contents:**

Project work on Applied Microbiology

**Course Code:** **DSE(PR) - 404**
**Course Title:** **Biochemistry – IV ( Project Work)**
**Nature of the Course :** **DSE**
**Total Credit Assigned :** **4**
**Total Marks :** **100**
**Distribution of Credit:** **L-0 T-0 P-4**

**Contents:**

Project work on Biochemistry

**Course Code:** **DSE(PR) - 405**
**Course Title:** **Integrative Biology – IV (Project Work)**
**Nature of the Course :** **DSE**
**Total Credit Assigned :** **4**
**Total Marks :** **100**

**Distribution of Credit:** **L-0 T-0 P-4**

**Contents:**

Project work on Integrative Biology

**Course Code:** **DSE(PR) - 406**
**Course Title:** **Drug Design – IV (Project Work)**
**Nature of the Course :** **DSE**
**Total Credit Assigned :** **4**
**Total Marks :** **100**
**Distribution of Credit:** **L-0 T-0 P-4**

**Contents:**

Project work on Drug Design