# Programme Structure

## BACHELOR OF SCIENCE (Hons.) IN BIOTECHNOLOGY

## BACHELOR OF SCIENCE (Hons. with Research) IN BIOTECHNOLOGY

## Course Code: SBR0404

## Department of Life Sciences

## School of Basic Sciences & Research

## Sharda University

## (Batch - 2023-2027)

# Programme Structure
# School of Basic Sciences & Research
# B.Sc. (Hons.) in Biotechnology (Semester: 01)
# Session: 2023-2024

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | BSM104 | Fundamentals of Biochemistry | 4 | 0 | 0 | 4 | Major |
| 2. | BBI101<br>Or<br>BBI102 | Basics of Microbiology<br>Or<br>Applications of Biomolecules | 3<br>Or<br>4 | 0<br>Or<br>0 | 0<br>Or<br>0 | 3<br>Or<br>4 | Multidisciplinary |
| 3. | CHE112 | Chemistry III/Minor | 3 | 0 | 0 | 3 | Minor/Elective |
| 4. | ARP101 | Communicative English-1 | 1 | 0 | 2 | 2 | Ability Enhancement Course |
| 5. | VAC103 | Environmental Management | 3 | 0 | 0 | 3 | Value Added Course |
| **PRACTICAL COURSES** | | | | | | | |
| 6. | BBI104 | Fundamentals of Biochemistry Lab | 0 | 0 | 2 | 1 | Major |
| 7. | BBI103* | Basics of Microbiology (Lab) | 0 | 0 | 2 | 1 | Major |
| 8. | VOL101 | Essential Techniques in Life Sciences-1 | 0 | 0 | 6 | 3 | Skill Enhancement Course |
| | | | **TOTAL CREDITS** | | | **20** | |

*****BBI103 is a lab that would be opted if BBI101 is opted.

# Programme Structure
# School of Basic Sciences & Research
# B.Sc. (Hons.) in Biotechnology (Semester: 02)
# Session: 2023-2024

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | BSB120 | Cell and Molecular Biology | 4 | 0 | 0 | 4 | Major |
| 2. | BBI111 | Principle of Bioinstrumentation | 3 | 0 | 0 | 3 | Major |
| 3. | PHR101 | Introduction to Renewable energy and management/Minor | 3 | 0 | 0 | 3 | Minor (Open Elective) |
| 4. | ARP102 | Communicative English-2 | 1 | 0 | 2 | 2 | Ability Enhancement Course |
| 5 | VAC110 | Yoga for Holistic Development | 0 | 1 | 4 | 3 | Value Added Course |
| **PRACTICAL COURSES** | | | | | | | |
| 6. | VOL102 | Essential Techniques in Life Sciences-2 | 0 | 0 | 6 | 3 | Skill Enhancement Course |
| 7. | BBI112 | Basics of Cell and Molecular Biology (Lab) | 0 | 0 | 2 | 1 | Major |
| 8. | BBI113 | Principle of Bioinstrumentation (Lab) | 0 | 0 | 2 | 1 | Major |
| **TOTAL CREDITS** | | | | | | **20** | |

# Programme Structure
# School of Basic Sciences & Research
# B.Sc. (Hons.) in Biotechnology (Semester: 03)
# Session: 2024-2025

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | BBT209 | Genetics | 4 | 0 | 0 | 4 | Major |
| 2. | BBI201 | Basic Immunology | 4 | 0 | 0 | 4 | Major |
| 3. | BBT211<br>Or<br>BMB111 | Biophysics<br>Or<br>Physical and chemical aspects of biological sciences | 4<br>Or<br>4 | 0<br>Or<br>0 | 0<br>Or<br>0 | 4<br>Or<br>4 | Multidisciplinary |
| 4. | PHR201 | Renewable energy resources/Minor | 3 | 0 | 0 | 3 | Minor (Open Elective) |
| 5. | ARP207 | Logical Skill Building and Soft Skills | 1 | 0 | 2 | 2 | Ability Enhancement Course |
| **PRACTICAL COURSES** | | | | | | | |
| 6. | VOL201 | Essential Techniques in Life Sciences-3 | 0 | 0 | 6 | 3 | Skill Enhancement Course |
| 7. | BBI202 | Basic Immunology Lab | 0 | 0 | 2 | 1 | Major |
| 8. | RBL001 | Research Based Learning-1 | 0 | 0 | 4 | Audit | Major (Project) |
| **TOTAL CREDITS** | | | | | | **21** | |

# Programme Structure
# School of Basic Sciences & Research
# B.Sc. (Hons.) in Biotechnology (Semester: 04)
# Session: 2024-2025

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | BBI212 | Plant Diversity | 5 | 0 | 0 | 5 | Major |
| 2. | BSB206 | Enzyme Technology | 4 | 0 | 0 | 4 | Major |
| 3. | BBI213<br>Or<br>BBI214 | Introduction to Genetic Engineering<br>Or<br>Introduction to Human Physiology | 3<br>Or<br>5 | 0<br>Or<br>0 | 0<br>Or<br>0 | 3<br>Or<br>5 | Multidisciplinary |
| 4. | CHE113 | Chemistry IV/Minor | 3 | 0 | 0 | 3 | Minor (Open Elective) |
| 5. | ARP305 | Personality Development and Decision Making | 1 | 0 | 2 | 2 | Ability Enhancement Course |
| **PRACTICAL COURSES** | | | | | | | |
| 6. | RBL002 | Research Based Learning -2 | 0 | 0 | 4 | AUDIT | Major (Project) |
| 7. | BSP205 | *Genetic Engineering (Lab) | 0 | 0 | 4 | 2 | Multidisciplinary |
| | | | | | **TOTAL CREDITS** | **19** | |

*Genetic Engineering (Lab) BSP205 is a part of BBI213.

# Programme Structure
# School of Basic Sciences & Research
# B.Sc. (Hons.) in Biotechnology (Semester: 05)
# Session: 2025-2026

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | BBI301 | Fundamentals of Bioprocess Technology | 5 | 0 | 0 | 5 | Major |
| 2. | BBI302 | Plant Anatomy & Physiology | 3 | 0 | 0 | 3 | Major |
| 3. | BBI303 | Animal Diversity | 3 | 0 | 0 | 3 | Major |
| 4. | BBI304<br>Or<br>FST314 | Biochemistry of Metabolic Pathways<br>Or<br>Food waste management | 3<br>Or<br>3 | 0<br>Or<br>0 | 0<br>Or<br>0 | 3<br>Or<br>3 | Multidisciplinary |
| **PRACTICAL COURSES** | | | | | | | |
| 5. | BBI305 | Plant Anatomy & Physiology Lab | 0 | 0 | 4 | 2 | Major |
| 6. | BBI306 | Animal Diversity Lab | 0 | 0 | 2 | 1 | Major |
| 7. | INC001 | Industry Connect | 0 | 0 | 4 | 2 | Survey<br>(Value Added Course) |
| 8. | RBL003 | Research Based Learning - 3 | 0 | 0 | 2 | 1 | Major (Project) |
| | | **TOTAL CREDITS** | | | | **20** | |

# Programme Structure
# School of Basic Sciences & Research
# B.Sc. (Hons.) in Biotechnology (Semester: 06)
# Session: 2025-2026

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | BBI311 | Application of Animal Biotechnology | 3 | 0 | 0 | 3 | Major |
| 2. | BBI312 | Fundamentals of Plant Biotechnology | 3 | 0 | 0 | 3 | Major |
| 3. | BBI313 | Fundamentals of Environmental Microbiology | 3 | 0 | 0 | 3 | Major |
| 4. | CHE111 | Chemistry II/MOOC/Minor | 3 | 0 | 0 | 3 | Minor (Open Elective) |
| **PRACTICAL COURSES** | | | | | | | |
| 5. | BBI314 | Application of Animal Biotechnology Lab | 0 | 0 | 4 | 2 | Major |
| 6. | BBI315 | Fundamentals of Plant Biotechnology Lab | 0 | 0 | 2 | 1 | Major |
| 7. | BSP310 | Environmental Microbiology Lab | 0 | 0 | 4 | 2 | Major |
| 8. | CCU108 | Community Connect | 0 | 0 | 4 | 2 | Survey (Value Added Course) |
| 9. | RBL004 | Research Based Learning- 4 | 0 | 0 | 2 | 1 | Major (Project) |
| **TOTAL CREDITS** | | | | | | **20** | |

# Programme Structure
# School of Basic Sciences & Research
# B.Sc. (Hons.) in Biotechnology (Semester: 07)
# Session: 2026-2027

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | BBT406 | Cell Signaling & Cancer Biology | 4 | 0 | 0 | 4 | Major |
| 2. | BBI401 | Biostatistics, Bioethics & IPR | 4 | 0 | 0 | 4 | Major |
| 3. | BBI402 | Introduction to Nanotoxicology | 3 | 0 | 0 | 3 | Major |
| 4. | BBI403<br>Or<br>FST413 | Proteomics<br>Or<br>Functional Food and nutraceuticals | 3<br>Or<br>4 | 0<br>Or<br>0 | 0<br>Or<br>0 | 3<br>Or<br>4 | Multidisciplinary |
| 5. | CHE101 | Fundamentals of Chemistry/MOOC/Minor | 4 | 0 | 0 | 4 | Minor/Open Elective |
| **PRACTICAL COURSES** | | | | | | | |
| 6. | BBI404 | Introduction to Nanotoxicology Lab | 0 | 0 | 2 | 1 | Major |
| 7. | BBI140 | *Proteomics Lab | 0 | 0 | 2 | 1 | Multidisciplinary |
| | | | | | **TOTAL CREDITS** | **20** | |

***Proteomics (Lab) BBI140 is a part of BBI403.**

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# Programme Structure
## School of Basic Sciences & Research
## B.Sc. (Hons. with Research.) in Biotechnology (Semester: 07)
## Session: 2026-2027

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | BBT406 | Cell Signaling & Cancer Biology | 4 | 0 | 0 | 4 | Major |
| 2. | BBI401 | Biostatistics, Bioethics & IPR | 4 | 0 | 0 | 4 | Major |
| 3. | BBI402 | Introduction to Nanotoxicology | 3 | 0 | 0 | 3 | Major |
| 4. | BBI414 | Fundamental Bioinformatics | 3 | 0 | 0 | 3 | Major |
| 5. | CHE101 | Fundamentals of Chemistry/MOOC/Minor | 4 | 0 | 0 | 4 | Minor/Open Elective |
| **PRACTICAL COURSES** | | | | | | | |
| 6. | BBI415 | Fundamental Bioinformatics Lab | 0 | 0 | 2 | 1 | Major |
| 7. | BBI404 | Introduction to Nanotoxicology Lab | 0 | 0 | 2 | 1 | Major |
| 8. | PJI401 | Project | 0 | 0 | 6 | 3 | Training/Project |
| | | **TOTAL CREDITS** | | | | **23** | |

# Programme Structure
# School of Basic Sciences & Research
# B.Sc. (Hons) in Biotechnology (Semester: 08)
# Session: 2026-2027

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | BBI411 | Functional Genomics | 4 | 0 | 0 | 4 | Major |
| 2. | BBI412 | Application of Industrial Biotechnology | 4 | 0 | 0 | 4 | Major |
| 3. | BBI413 | Microbial Diversity and Taxonomy | 4 | 0 | 0 | 4 | Major |
| 4. | BBI414<br>Or<br>FST419 | Fundamental Bioinformatics<br>Or<br>Basic concepts of research design and methodology | 3<br>Or<br>4 | 0<br>Or<br>0 | 0<br>Or<br>0 | 3<br>Or<br>4 | Multidisciplinary |
| 5. | | MOOC/Minor | 4 | 0 | 0 | 4 | Minor (Open Elective) |
| 6. | BBI415 | *Fundamental Bioinformatics Lab | 0 | 0 | 2 | 1 | Major |
| | | | | | **TOTAL CREDITS** | **20** | |

*Fundamental Bioinformatics Lab is a part of BBI414

# Programme Structure
# School of Basic Sciences & Research
# B.Sc. (Hons. with research.) in Biotechnology (Semester: 08)
# Session: 2026-2027

| S. No. | Course Code | Course Name | Teaching Load | | | Credits | Type of Course |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **THEORY COURSES** | | | | | | | |
| 1. | FST419 | Basic Concepts of Research and Design and Methodology | 4 | 0 | 0 | 4 | Major |
| 2. | | MOOC/Minor | 4 | 0 | 0 | 4 | Minor/Open Elective |
| **PRACTICAL COURSES** | | | | | | | |
| 3. | PJI402 | Project | 0 | 0 | 18 | 9 | Research Project |
| | | **TOTAL CREDITS** | | | | **17** | |

# Course Module

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# SEMESTER I

**Course code: BSM104 Course Title: Fundamentals of Biochemistry**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** | |
| **Branch: Biotechnology** | | **SEMESTER: 1st** | |
| **1** | Course Code | **BSM104** | |
| **2** | Course Title | **Fundamentals of Biochemistry** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1. To study the structure and function of macromolecules present in biological systems<br>2. Understanding the general properties of lipids, amino acids and carbohydrates<br>3. To learn the hierarchical level of proteins<br>4. To study the structure as well as properties of DNA and RNA | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1**:** Memorize the basic concepts of biochemistry<br>CO2**:** Identify the structure and functions of carbohydrates.<br>CO3**:** Demonstrate the types and function of lipids, fatty acids and vitamins<br>CO4**:** Differentiate between the proteins and various types of it.<br>CO5: Explain about various nucleic acid molecules and DNA structure types that exist in nature.<br>CO6: Investigate the basic concepts of biomolecules and use those concepts to understand the structure and basic functions of cell membrane. | |
| **7** | Course Description | This course comprises of the structure, function, properties and significance of various macromolecules found in biological systems. Several different macromolecules viz. lipids, carbohydrates, amino acids, proteins, and nucleic acids will be studied in detail. | |
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Biochemistry** | CO1,CO6 |
| | A | Bonds: Covalent, non-covalent bonds, hydrophilic and hydrophobic interactions, hydrogen bonding and their influence on structure of biomolecules. | |
| | B | Acids, bases, pH, and ionization of water., Buffers, concept of oxidation and reduction, concept of electronegative and electropositive ions. | |
| | C | Concept of Molarity, Molality, Normality, Structure of water, polarity of water, biological functions of water inside the cell and human body | |
| | **Unit 2** | **Carbohydrate: Structure and functions** | CO2, CO6 |
| | A | Monosaccharide: aldoses and ketoses, configuration and conformation, concept of reducing and non-reducing sugars, stereoisomerism | |
| | B | Oligosaccharides: Conformation of Pyranose and Furanose Rings, Sucrose, Lactose, Maltose, Isomaltose, Trehalose | |

| | | | |
|---|---|---|---|
| | C | Polysaccharides: Storage (starch and glycogen) and structural (cellulose and chitin). Important sugar derivatives and glycosaminoglycans. Importance of carbohydrates. | |
| | **Unit 3** | **Lipids and Vitamins** | CO3, CO6 |
| | A | Structure and properties of the fatty acids (Saponification, acid values and iodine number, saturated, unsaturated, essential, non-essential fatty acids) | |
| | B | Triacylglycerols, phospholoipids and derivatives viz., phosphoglycerides; lacithins, cephalins, plasmogens, phosphatidyl inositol, Sphingomylin, glycolipids (cerebrosides and gangliosides) and cholesterol; membrane lipids | |
| | C | Vitamins: Introduction, types, scientific names, food sources, function and diseases. | |
| | **Unit 4** | **Protein structure** | CO4, CO6 |
| | A | Introduction to amino acids and proteins, Amino acids: classification based on R chain, DL configuration, | |
| | B | Physical properties and ionizability of Amino acids (zwitterion), pK values, isoelectric point | |
| | C | Chemical properties of peptide bond. Primary, secondary (alpha helix and beta pleated sheet), tertiary and quaternary structure of proteins, Ramachandran plot | |
| | **Unit 5** | **Nucleic Acids: Structure and functions** | CO5, CO6 |
| | A | Nitrogenous bases (purines & pyrimidines)**,** Nucleosides & Nucleotides | |
| | B | Biologically important nucleotides, Double helical model of DNA, Introduction and structure forces responsible for A, B & Z DNA | |
| | C | Chemical structures of DNA (Watson-Crick Model) and RNA. Explanation of Hydrogen bonding between the two DNA molecules, Significance of DNA and RNA. | |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | 1. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA | |
| | Other References | 1. S Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | - | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO2** | 2 | 2 | 1 | - | 1 | 2 | 1 | - | 3 | 2 | 2 | 1 | 1 |
| **CO3** | 3 | 2 | 2 | - | 2 | 2 | 1 | - | 3 | 2 | 2 | 1 | 1 |
| **CO4** | 3 | 2 | 1 | - | 1 | - | 1 | 1 | 2 | 1 | 1 | 2 | 2 |
| **CO5** | 2 | 1 | 2 | - | 1 | 1 | - | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO6** | 3 | 2 | 3 | - | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| **Avg** | 2.7 | 1.8 | 1.7 | - | 1.3 | 1.6 | 1.2 | 1.3 | 2.3 | 1.5 | 1.8 | 1.3 | 1.2 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI101** **Course Title: Basics of Microbiology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** | |
| **Branch: Biotechnology** | | **SEMESTER: I$^{st}$** | |
| **1** | Course Code | **BBI101** | |
| **2** | Course Title | **Basics of Microbiology** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | Multidisciplinary | |
| **5** | Course Objective | Course Objectives:<br>1. This course has been designed to make students understand the basic characteristics of microbes<br>2. To know about basis principle and to understand the methods of sterilization<br>3. Students understand the basic structure of Bacteria | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Memorize the history of microbiology and its basic concepts.<br>CO2: Summarize the various classification of bacteria<br>CO3: Identify bacteria based on its morphology, cell structure<br>CO4: Examine the growth in bacteria and how to isolate bacterial species<br>CO5: Interpret the ways to control microbial growth. Also will develop basic understanding of viruses<br>CO6: Improve on the knowledge on microbial diversity and its role in human society | |
| **7** | Course Description | Course Description:<br>Microbiology course outlines the general characteristics of different microorganisms and also provides the basic knowledge of significance of different microbes affecting the human beings. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction of Microbiology and Microbial Diversity** | CO1,CO6 |
| | A | History and scope of microbiology, concept of cell, prokaryotic and eukaryotic cell (plant cell and animal cell) Spontaneous Generation Versus Biogenesis, Germ theory of disease | |
| | B | Major contribution of scientists– Leeuwenhoek, Edward Jenner, Alexander Flemming, Joshep Lister, Robert Koch, Louis Pasteur, Hargobind Khorana. | |
| | C | Whittaker's 5 kingdom concept; major Groups of Microorganisms introduction – bacteria, archaea, virus, fungi (yeasts and moulds), algae, protozoa | |
| | **Unit 2** | **Classification of Bacteria** | CO2, CO6 |
| | A | Basis of microbial classification, molecular approaches in microbial classification, concept of microbial species; | |

| | | | |
|---|---|---|---|
| | B | Principle and classification of bacteria on the basis of Bergey's manual of Deterrminative bacteriology; Nutritional classification of Bacteria | |
| | C | Prochlorons, acidophiles, alkaliphiles, thermophiles, barophiles, non-culturable bacteria. Methanogens, Methanotrophs and Methylotrophs, Psychrophiles | |
| | **Unit 3** | **Morphology of Bacteria** | CO3, CO6 |
| | A | Morphological study of bacteria- The Size, Shape, and Arrangement of Bacterial Cells, components of bacterial cell (nucleoid, flagella, inclusion bodies, plasmids, pili, fimbriae) | |
| | B | Gram negative and Gram-positive bacteria cell wall and membrane, spores and cyst. | |
| | C | Brief overview on Archaea, archaea cell wall, Cyanobacteria, PPLO | |
| | **Unit 4** | **Growth and Sporulation in Bacteria** | CO4, CO6 |
| | A | Modes of cell division (Binary fission; budding and septum formation, fragmentation); Growth curve; Conjugation | |
| | B | Pure culture, Method of isolating pure culture (Streak method, Pour-plate and spread plate technique); Synchronous and asynchronous | |
| | C | Growth inhibitory substances (temperature, acidity, alkalinity, water availability, oxygen) | |
| | **Unit 5** | **Microbial Growth and control of virus** | CO5, CO6 |
| | A | Antibiotics mode of action on bacteria and antibiotic resistance; | |
| | B | Physical and chemical methods of control of Microorganisms; Microbes and Human welfare (medical and food industry) | |
| | C | Ultra-structure of Virus, Lytic and lysogenic life cycle of virus | |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Prescott, Harley and Kelvin – Microbiology, IInd ed. TMH Publication | |
| | Other References | Microbiology- Pelczar, M.J. Reid, R.D. and E.C.S. Chan, Tata McGraw Hill, New Delhi.1977 (4th Edition); General Microbiology: Roger & Strainer et.al. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | - | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 2 | 1 | - | 1 | 2 | 1 | - | 3 | 2 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 2 | - | 2 | 2 | 1 | - | 3 | 2 | 2 | 1 | 2 |
| **CO4** | 3 | 2 | 1 | 1 | 1 | - | 1 | 1 | 2 | 1 | 1 | 2 | 2 |
| **CO5** | 3 | 1 | 2 | 1 | 1 | 1 | - | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO6** | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| **Avg** | 3.0 | 2.0 | 1.6 | 1.0 | 1.3 | 1.6 | 1.2 | 1.2 | 2.3 | 1.5 | 1.8 | 1.3 | 1.3 |

***1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)***

**Course code: CHE112** **Course Title: Chemistry III**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch** | |
| **Programme: B.Sc.** | | **Current Academic Year:** | |
| **Branch: Biotechnology** | | **Semester: 1st** | |
| 1 | Course Code | CHE112 | |
| 2 | Course Title | Chemistry III | |
| 3 | Credits | 3 | |
| 4 | Contact Hours<br><br>(L-T-P) | 3-0-0 | |
| | Course Status | Minor | |
| 5 | Course Objective | 1. To discuss importance of clean water and water treatment.<br>2. To explain the method to determine hardness and alkalinity in water sample and discussion on boiler trouble at industrial scale using different suitable technology<br>3. To describe the basic concepts of spectroscopy to apply in various engineering applications.<br>4. To provide an introduction to the basic concepts in Electrochemistry and apply them to understand corrosion.<br>5. To equip the students with the knowledge of chemistry and its various applications. | |
| 6 | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Realize the importance of clean and healthy water by giving knowledge about water quality parameters and cleaning measures.<br>CO2: Explain various kind of boiler troubles, water desalination, softening and treatment method.<br>CO3: Discuss the chemistry of various type of Cement, Ceramics and Refractories and its industrial importance.<br>CO4: Illustrate the chemical properties of material by having the knowledge of spectroscopic techniques.<br>CO5: Describe the basics of electrochemistry and apply it to understand the corrosion of a metals.<br>CO6: Have a thorough grounding in water technology, cement chemistry, basic spectroscopic techniques and electrochemistry to solve the contemporary issues. | |
| 7 | Course Description | The course includes the water technology, Electrochemistry and corrosion, chemistry of cement, ceramic and refractories, basic spectroscopic techniques. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Water Technology I** | |
| | A | Drinking water standards, Water quality parameters, hardness: definition and expression, estimation of hardness by EDTA method. Turbidity. | CO1, CO6 |
| | B | Alkalinity and acidity – determination by titrimetry, Dissolved Oxygen (DO). Ill effects of fluoride, nutrients (N, P, etc.) and dissolved metals. | CO1, CO6 |
| | C | Biological oxygen demand (BOD), Chemical oxygen demand | CO1, CO6 |

| | | | |
|---|---|---|---|
| | | (COD)Determination of chloride present in water (by Mohr's method), | |
| | **Unit 2** | **Water Technology II** | |
| | A | Boiler Troubles: Carry Over, Priming, Foaming, Scale, Sludge, Corrosion, Caustic Embrittlement. | CO2, CO6 |
| | B | Desalination of water; Softening of water: Ion exchange process, Zeolite process. | CO2, CO6 |
| | C | Municipal Water treatment process - screening, sedimentation, flocculation; Coagulation, Filtration (slow sand and rapid sand), disinfection-chlorination (break-point chlorination). | CO2, CO6 |
| | **Unit 3** | **Cement, Ceramics and Refractories** | |
| | A | Cement: Raw material, composition, manufacturing process and application of Portland cement, Chemistry of setting of cement | CO3, CO6 |
| | B | Ceramics and Refractories: Introduction, classification | CO3, CO6 |
| | C | Properties, raw materials, manufacturing and applications | CO3, CO6 |
| | **Unit 4** | **Spectroscopy** | |
| | A | Introduction of UV-Vis spectroscopy, Lamberts Beer's law. Different type of electronic transitions Chromophore, auxochrome, effect of conjugation on chromophore and applications. | CO4, CO6 |
| | B | Introduction of Atomic Absorption Spectroscopy (AAS), Principle of AAS, Instrumentation. | CO4, CO6 |
| | C | Detection Limit and Sensitivity, Application of AAS | CO4, CO6 |
| | **Unit 5** | **Electrochemistry and corrosion** | |
| | A | Electrochemistry: Redox reactions, Nernst Equation, Electrochemical cells-Galvanic cells and Concentration cell. | CO5, CO6 |
| | B | Electrode potentials and its relevance to oxidation and reduction, measurement of EMF under standard conditions, determination of pH using Hydrogen electrode. | CO5, CO6 |
| | C | ypes of corrosion, mechanism of Electrochemical corrosion, galvanic corrosion and protection against electrochemical corrosion | CO5, CO6 |
| | Mode of examination | Theory | |
| | Text book/s* | Puri, B.R., Sharma, L.R., and Pathania, M.S., "Principles of Physical Chemistry", Vishal publishing company.<br>Engineering Chemistry by Jain & Jain. | |
| | Other References | Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | - | 2 | 3 | 2 | 2 | 1 | 1 | 2 | - | - |
| **CO2** | 1 | 3 | 1 | - | 1 | 2 | 1 | - | 1 | - | 1 | - | - |
| **CO3** | 1 | 1 | 1 | - | 1 | 2 | - | - | - | - | - | - | - |
| **CO4** | 2 | 2 | - | - | - | - | 1 | - | 1 | 1 | 3 | - | - |
| **CO5** | 2 | 2 | 2 | - | - | 2 | 1 | 1 | 1 | 1 | 2 | - | - |
| **CO6** | 2 | 2 | 3 | - | 2 | 3 | 2 | 2 | 2 | 2 | 2 | - | - |
| **Avg** | 1.7 | 2.2 | 2.0 | - | 1.5 | 2.4 | 1.4 | 1.7 | 1.2 | 1.3 | 2.0 | - | - |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI104** **Course Title: Fundamentals of Biochemistry Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** |
| **Branch: Biotechnology** | | **SEMESTER: I$^{st}$** |
| **1** | Course Code | BBI104 |
| **2** | Course Title | **Fundamentals of Biochemistry Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | Compulsory |
| **5** | Course Objective | This course is designed to provide an introductory experience to conducting experiments in a biochemistry laboratory. The course covers a broad spectrum of modern techniques and their underlying physical, chemical and biological principles |
| **6** | Course Outcomes | After finishing the course, the students will be able to:<br>CO1: Define and distinguish between mono-, di-, and oligosaccharides present in different samples<br>CO2: Illustrate the estimation of starch and lipids<br>CO3: Identify test activity of enzymes<br>CO4: Examine the test and analyses for nucleic acids<br>CO5: Interpret the test and analyses for amino acids<br>CO6: Maximize the understanding the identification techniques of biomolecules |
| **7.** | Course Objective | This course is designed to provide an introductory experience to conducting experiments in a biochemistry laboratory. The course covers a broad spectrum of modern techniques and their underlying physical, chemical and biological principles |

| 8 | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Introduction to Lab practices** | |
| | A | Good Lab Practices | CO1, CO6 |
| | B | Handling of acids and solutions | CO1,CO6 |
| | C | To use pipettes | CO1,CO6 |
| | **Unit 2** | **Solutions** | |
| | A | Concept of Molarity, Molality and Normality | CO2, CO6 |

| | | | |
|---|---|---|---|
| | B | Preparation of buffers | CO2, CO6 |
| | C | Autoclave and viva | CO2, CO6 |
| | **Unit 3** | **Carbohydrates test** | |
| | A | Practical based on estimation of carbohydrates | CO3, CO6 |
| | B | Colorimetric estimation of carbohydrates | CO3, CO6 |
| | C | Quantitative estimation of carbohydrate | CO3, CO6 |
| | **Unit 4** | **Lipids Test** | |
| | A | Practical related to estimation of starch | CO4, CO6 |
| | B | Detection of Lipids | CO4, CO6 |
| | C | Estimation of Lipids | CO4, CO6 |
| | **Unit 5** | **Estimation of nucleic acids** | |
| | A | Concept of Spectrophotometer | CO5, CO6 |
| | B | Qualitative estimation of nucleic acids | CO5, CO6 |
| | C | Quantitative estimation of nucleic acids | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | |
| | Weightage Distribution | CA: 25% / CE: 25% / ESE: 50% | |
| | Text book | Sawhney S.K. and Singh R. **Introductory Practical Biochemistry.** | |
| | Reference books | Practical manual of Biotechnology by Ritu Mahajan, Jitendar Sharma, RK Mahajan, Vayu Education of India. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | - | 2 | 1 | 2 | 1 | 2 |
| CO2 | 2 | 2 | 1 | 1 | - | 2 | 1 | - | 3 | 2 | 2 | 1 | 2 |
| CO3 | 3 | 2 | 2 | 1 | - | 2 | 1 | - | 3 | 2 | 2 | 1 | 2 |
| CO4 | 3 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 2 | 2 |
| CO5 | 3 | 1 | 2 | 1 | - | 1 | - | - | 2 | 1 | 2 | 1 | 1 |
| CO6 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | - | 2 | 2 | 2 | 2 | 1 |
| Avg | 2.8 | 1.8 | 1.7 | 1.3 | 1.3 | 1.6 | 1.2 | - | 2.3 | 1.5 | 1.8 | 2.8 | 1.8 |

**Slight (Low) 2-Moderate (Medium) 3-Substantial (High)**

**Course code: BBI103** **Course Title: Basics of Microbiology Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** |
| **Branch: Biotechnology** | | **SEMESTER: I$^{st}$** |
| **1** | Course Code | **BBI103** |
| **2** | Course Title | **Basics of Microbiology Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | Multidisciplinary |
| **5** | Course Objective | To explain relationships and apply appropriate terminology relating to the structure, metabolism, and ecology of prokaryotic microorganisms, eukaryotic microorganisms, and viruses. To explain the principles of physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious diseases. To develop the appropriate laboratory skills and techniques related to the isolation, staining, identification, assessment of metabolism, and control of microorganisms. To develop an information base for making personal health decisions in regard to infectious diseases. |
| **6** | Course Outcomes | After finishing the course, the students will be able to<br>CO1: Understand Lab Ethics<br>CO2: Explain how to isolate single colony from mixed culture<br>CO3: Illustrate the bacterial characteristics<br>CO4: Infer the optimum conditions for the bacterial growth<br>CO5: Discriminate between gram positive and negative bacteria<br>CO6: Discuss the importance of learning microbiological techniques |
| **7** | Course description | **Course Description:**<br>To explain the principles of physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious disease |

| 8 | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Laboratory Introduction** | |
| | A | Good laboratory practice (GLP) | CO1, CO6 |
| | B | Introduction, use, precautions and care of Laminar flow hood | CO1,CO6 |
| | C | Introduction,use, precautions and care of pH meter and Autoclave | CO1,CO6 |
| | **Unit 2** | **Techniques to isolate pure bacterial colony from mixed culture** | |

| | | | |
|---|---|---|---|
| | A | Preparation of media and autoclave | CO2, CO6 |
| | B | Pour plate method | CO2, CO6 |
| | C | Serial dilution, Streaking method | CO2, CO6 |
| | **Unit 3** | **Characterization of the bacteria** | |
| | A | Characterization of the bacterial colony | CO3, CO6 |
| | B | Demonstrate the working of Microscope | CO3, CO6 |
| | C | Characterization of bacterial cells under microscopy | |
| | **Unit 4** | **Bacterial Growth** | |
| | A | Enumeration of bacteria by serial dilution agar plate technique | CO4, CO6 |
| | B | Bacterial Growth at optimum pH | CO4, CO6 |
| | C | Bacterial Growth at optimum Temperature | CO4, CO6 |
| | **Unit 5** | **Staining** | |
| | A | Simple staining of Bacteria | CO5, CO6 |
| | B | Negative Staining of Bacteria | CO5, CO6 |
| | C | Gram Staining of bacteria | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | |
| | Weightage Distribution | CA: 25% / CE: 25% / ESE: 50% | |
| | Text books | Practical manual of Biotechnology by Ritu Mahajan, Jitendar Sharma, RK Mahajan, Vayu Education of India | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | - | 2 | 1 | 2 | 1 | 2 |
| CO2 | 2 | 2 | 1 | 1 | - | 2 | 1 | - | 3 | 2 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 1 | - | 2 | 1 | - | 3 | 2 | 2 | 1 | 2 |
| CO4 | 3 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 2 | 2 |
| CO5 | 3 | 1 | 2 | 1 | - | 1 | - | - | 2 | 1 | 2 | 1 | 1 |
| CO6 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | - | 2 | 2 | 2 | 2 | 1 |
| Avg | 2.8 | 1.8 | 1.7 | 1.1 | 1.3 | 1.6 | 1.2 | - | 2.3 | 1.5 | 1.8 | 2.8 | 1.8 |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

**Course code: BBI102** **Course Title: Application of Biomolecules**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** | |
| **Branch: Biotechnology** | | **SEMESTER: 1st** | |
| **1** | Course Code | **BBI102** | |
| **2** | Course Title | **Application of Biomolecules** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Multidisciplinary | |
| **5** | Course Objective | 1. To study the structure and function of macromolecules present in biological systems<br>2. Understanding the general properties of biomolecules<br>3. To learn the structure and function of tertiary and quaternary proteins | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1**:** to Understand the concept of solutions in biological solutions<br>CO2**:** Identify the different biomolecules in a given mixture.<br>CO3**:** Demonstrate the concept and structures of amino acids and protein<br>CO4**:** Differentiate between tertiary and quaternary structure of protein.<br>CO5: Explain the concept of the basic techniques used in Biotechnology.<br>CO6: Investigate the basic concepts of biomolecules and use those concepts to understand the structure and basic functions of cell membrane. | |
| **7** | Course Description | Student must be able to understand when and how to use which technique of a given biological problems. Also, to understand and interpret the result obtained from various techniques | |
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Chemistry** | CO1,CO6 |
| | A | Understand the concept of pH and acid base | |
| | B | Molarity, Molality, Normality (concept and numerical problems) | |
| | C | Understanding the concept of buffers, serial dilutions (numerical problems) | |
| | **Unit 2** | **To learn the various test for identification** | CO2, CO6 |
| | A | Carbohydrates | |
| | B | Proteins | |
| | C | Lipids | |
| | **Unit 3** | **Amino acids** | CO3, CO6 |
| | A | Structure and properties of amino acids | |
| | B | Introduction to Ramachandran plot | |

| | | | |
|---|---|---|---|
| | C | Tertiary and Quaternary structure of protein- Hemoglobin; difference between myoglobin and hemoglobin | |
| | **Unit 4** | **Spectrophotometer** | CO4, CO6 |
| | A | Principle of spectrophotometer, the Lamber Beer's law: working, advantages, uses, limitations | |
| | B | UV/VIS absorption spectroscopy: Principle, working, advantages, uses, limitations | |
| | C | Theoretically plot absorption spectrum of DNA and protein using BSA/Egg Albumin and find λmax | |
| | **Unit 5** | **Electrophoresis** | CO5, CO6 |
| | A | Polarimetry: Determination of the percentage composition of optically active solution | |
| | B | Introduction to Electrophoresis: Principle, working, advantages, uses, limitations | |
| | C | Types of Electrophoresis: PAGE and Native gel Electrophoresis: Principle, working, advantages, uses, limitations | |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | 2. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA. | |
| | Other References | 2. S Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman<br>3. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.<br>4. Swayam - Government of India, https://swayam.gov.in/ | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 1 | - | - | 1 | - | 1 | 3 | - | 1 |
| **CO2** | 3 | 3 | 3 | 1 | 1 | - | 1 | 1 | - | 1 | 3 | - | 1 |
| **CO3** | 3 | 2 | 3 | 1 | 1 | - | 2 | - | - | 1 | 3 | - | 1 |
| **CO4** | 3 | 2 | 3 | 1 | 1 | - | 2 | 3 | 2 | 2 | 3 | - | 1 |
| **CO5** | 3 | 3 | 3 | 1 | 1 | - | 2 | 3 | 1 | 2 | 3 | - | 1 |
| **CO6** | 3 | 3 | 3 | 1 | 1 | - | 2 | 2 | 3 | 3 | 3 | - | 1 |
| **Avg** | 3.0 | 2.7 | 3.0 | 1.0 | 1.0 | - | 1.8 | 2.0 | 2.0 | 1.7 | 3.0 | - | 1.0 |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

**Course code:VAC103** **Course Title: Environmental Management**

| | | | |
|---|---|---|---|
| **School:** SSBSR | | **Batch: 2023-2027** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** | |
| **Branch: Biotechnology** | | **Semester: 1st** | |
| 1 | Course Code | **VAC103** | |
| 2 | Course Title | Environmental Management | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. Enable students to learn the concepts, principles and importance of environmental science<br>2. Provide students an insight of various causes of natural resource depletion and its conservation<br>3. Provide detailed knowledge of causes, effects and control of different types of environmental pollution and its effect on climate change, global warming and ozone layer depletion.<br>4. Provide knowledge of different methods of water conservation<br>5. Provide and enrich the students about sustainable practices and environmental management | |
| 6 | Course Outcomes | The students at the completion of the course will be able to:<br>CO1.Develop a better understanding of the principles and scope of environmental science<br>CO2. Acquire to learn various pollution causes, effects and control and solid waste management.<br>CO3. Interpret the effect of global warming and ozone layer depletion<br>CO4. Comprehend about various types of natural resources and its conservation<br>CO5. Develop a better understanding about sustainable practices and environmental management<br>CO6. Function effectively an overall understanding of various environmental components, its protection and management. | |
| 7 | Course Description | Environmental Science emphasises on various factors as<br>1. Importance and scope of environmental science<br>2. Natural resource conservation<br>3. Pollution causes, effects and control methods<br>4. Sustainable and Environmental environment | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Natural resource management** | |
| | A | Introduction to Natural Resources | CO1/CO6 |
| | B | Management of Land and Forest Resources | CO1/CO6 |
| | C | Water and Energy resource Management | CO1/CO6 |
| | **Unit 2** | **Environmental Pollution Management** | |
| | A | Air pollution Control and Water Pollution treatment Methods | CO2/CO6 |
| | B | Soil and Noise Pollution Management | CO2/CO6 |
| | C | Solid waste management | CO2/CO6 |
| | **Unit 3** | **Climate Change Mitigation** | |

| | | | | | |
|---|---|---|---|---|---|
| | A | Concept of Global Warming and greenhouse effect | | | CO3/CO6 |
| | B | zone layer Depletion and its consequences | | | CO3/CO6 |
| | C | limate change, its effect on ecosystem and its mitigation. Kyoto protocol and IPCC concerns on changing climate. | | | CO3/CO6 |
| | **Unit 4** | **Natural resource conservation and management** | | | |
| | A | Hot spots, Endangered and endemic species of India | | | CO4/CO6 |
| | B | Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions | | | CO4/CO6 |
| | C | Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. | | | CO4/CO6 |
| | **Unit 5** | **Sustainable practices and environmental management** | | | |
| | A | Sustainable development and sustainable consumption | | | CO4/CO6 |
| | B | Environmental Issues and Management in India | | | CO4/CO6 |
| | C | Environmental Management System (EMS) | | | CO4/CO6 |
| | Mode of examination | Theory | | | |
| | Weightage Distribution | CA | MSE | ESE | |
| | | 25% | 25% | 50% | |
| | Text book/s* | Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha, Pub: Orient Blackswan Pvt Ltd | | | |
| | Other References | Environmental Science by G. Tyler Miller, JR. and Scott E. Spoolman; Broks/Cole. | | | |

**CO-PO-PSO Mapping**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 1 | 3 | 3 | 1 | 1 | 3 | 1 | 1 | - | 3 |
| **CO2** | 3 | 2 | 1 | - | 1 | 3 | 1 | 3 | 3 | - | 1 | - | 2 |
| **CO3** | 2 | 1 | 1 | - | 1 | 3 | - | - | 3 | - | - | - | - |
| **CO4** | 2 | 1 | - | - | - | 3 | - | - | 1 | - | - | - | 2 |
| **CO5** | 1 | 2 | 1 | - | - | 3 | 1 | 1 | 1 | 1 | - | - | 2 |
| **CO6** | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | - | - | - |
| **Avg** | 2.2 | 1.7 | 1.6 | 1.0 | 1.5 | 3.0 | 1.3 | 1.8 | 2.3 | 1.7 | 1.7 | - | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

| | | | |
|---|---|---|---|
| **Schools:** SSBR | | **Batch :** 2023-2027 | |
| **Programme: B.Sc.** | | **Academic Year:** 2023-2024 | |
| **Branch: Biotechnology** | | **Semester:1st** | |
| 1 | Course Code | **ARP101** | |
| 2 | Course Title | Communicative English-1 | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P) | 1-0-2 | |
| 5 | Course Objective | To minimize the linguistic barriers that emerges in varied socio-linguistic environments through the use of English. Help students to understand different accents and standardize their existing English. Guide the students to hone the basic communication skills - listening, speaking, reading and writing while also uplifting their perception of themselves, giving them self-confidence and building positive attitude. | |
| 6 | Course Outcomes | After completion of this course, students will be able to:<br>CO1 Develop a better understanding of advanced grammar rules and write grammatically correct sentences<br>CO2 Acquire wide vocabulary and punctuation rules and learn strategies for error-free communication.<br>CO3 Interpret texts, pictures and improve both reading and writing skills which would help them in their academic as well as professional career<br>CO4 Comprehend language and improve speaking skills in academic and social contexts<br>CO5 Develop, share and maximise new ideas with the concept of brainstorming and the documentation of key critical thoughts articulated towards preparing for a career based on their potentials and availability of opportunities.<br>CO6 Function effectively in multi-disciplinary teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality | |
| 7 | Course Description | The course is designed to equip students, who are at a very basic level of language comprehension, to communicate and work with ease in varied workplace environment. The course begins with basic grammar structure and pronunciation patterns, leading up to apprehension of oneself through written and verbal expression as a first step towards greater employability. | |
| 8 | Outline syllabus – ARP 101 | | |
| | **Unit 1** | **Sentence Structure** | **CO Mapping** |
| | A | Subject Verb Agreement | CO1 |
| | B | Parts of speech | |
| | C | Writing well-formed sentences | |
| | **Unit 2** | **Vocabulary Building & Punctuation** | |
| | A | Homonyms/ homophones, Synonyms/Antonyms | CO1, CO2 |

| | | | |
|---|---|---|---|
| | B | Punctuation/ Spellings (Prefixes-suffixes/Unjumbled Words) | CO1, CO2 |
| | C | Conjunctions/Compound Sentences | CO1, CO2 |
| | **Unit 3** | **Writing Skills** | |
| | A | Picture Description – Student Group Activity | CO3 |
| | B | Positive Thinking - Dead Poets Society-Full-length feature film - Paragraph Writing inculcating the positive attitude of a learner through the movie \| SWOT Analysis – Know yourself | CO3, CO2, CO3 |
| | C | Story Completion Exercise –Building positive attitude - The Man from Earth (Watching a Full length Feature Film ) | CO2, CO3 |
| | D | Digital Literacy \| Effective Use of Social Media | CO3 |
| | **Unit 4** | **Speaking Skill** | |
| | A | Self-introduction/Greeting/Meeting people – Self branding | CO4 |
| | B | Describing people and situations - To Sir With Love ( Watching a Full length Feature Film ) | CO4 |
| | C | Dialogues/conversations (Situation based Role Plays) | CO4 |
| | **Unit 5** | **Professional Skills \| Career Skills** | |
| | A | Exploring Career Opportunities | CO4, CO5 |
| | B | Brainstorming Techniques & Models | CO4, CO5 |
| | C | Social and Cultural Etiquettes | CO4, CO5 |
| | D | Internal Communication | CO4, CO5 |
| | **Unit 6** | **Leadership and Management Skills** | |
| | A | Managerial Skills | CO6 |
| | B | Entrepreneurial Skills | CO6 |
| 9 | Evaluations | *Class Assignments/Free Speech Exercises / JAM Group Presentations/Problem Solving Scenarios/GD/Simulations ( 60% CA and 40% ETE* | *N/A* |
| 10 | Texts & References \| Library Links | • Blum, M. Rosen. *How to Build Better Vocabulary*. London: Bloomsbury Publication<br>• Comfort, Jeremy (et.al). *Speaking Effectively*. Cambridge University Press | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | - | - | - | 1 | 3 | - | - | - |
| **CO2** | - | - | - | - | - | - | - | - | 1 | 3 | - | - | - |
| **CO3** | - | - | - | - | - | - | - | - | 1 | 3 | - | - | - |
| **CO4** | - | - | - | - | - | - | - | - | 1 | 2 | - | - | - |
| **CO5** | - | - | - | - | - | - | - | - | 1 | 2 | - | - | - |
| **CO6** | - | - | - | - | - | - | - | - | 1 | 2 | - | - | - |
| **Avg** | - | - | - | - | - | - | - | - | 1.0 | 2.5 | - | - | - |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

# SEMESTER II

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** | |
| **Branch: Biotechnology** | | **SEMESTER: II$^{nd}$** | |
| **1** | Course Code | **BSB120** | |
| **2** | Course Title | **Cell and Molecular Biology** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | **Compulsory** | |
| **5** | Course Objective | Course Objective:<br>1. Understanding the concept of structure and function of biological cells and cell membrane<br>2. To understand the concept and functioning of the cell organelles<br>3. Discuss the replication of DNA<br>4. To understand the concept of transcription and post transcriptional modifications<br>5. Analyze the translation and gene regulation | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Define cell and plasma membrane<br>CO2: Illustrate the detailed structure of a cell<br>CO3: Organize how genetic information is stored in cells and how genetic information flows through replication<br>CO4: Sketch the concept of transcription and post modifications<br>CO5: Categorize the concept of translation and gene regulation<br>CO6: Elaborate how cell and how protein is formed from the DNA | |
| **7** | Course description | This course will to help us to understand how biological cells do have different minute organelles which coordinate with each other and perform all the functions and metabolic activities of the cell. Study this course will help them to explore the structure and function of cells. Student will learn about cell diversity that arises during its growth and how cells co-operate and communicate with each other in normal tissues. This course will help them to prepare for a wide range of careers both inside and outside the lab | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Overview of Cells and membrane system** | CO1,CO6 |
| | A | Cell theory, different types of cells: Prokaryotic and Eukaryotic cells, plant cell and animal cell | |
| | B | Cell cycle: mitosis and meiosis | |
| | C | Structure and function of nucleus, nucleolus, nucleiod | |
| | **Unit 2** | **Function and structure of cell organelles** | CO2, CO6 |

| | | | |
|---|---|---|---|
| | A | Basic understanding of DNA and RNA; Watson and Crick model of DNA | |
| | B | DNA Replication in prokaryotes and eukaryotes (telomere replication). | |
| | C | Semi-conservative, bidirectional and semi-discontinuous replication | |
| | **Unit 3** | **DNA replication** | CO3, CO6 |
| | A | Basic understanding of DNA and RNA; Watson and Crick model of DNA | |
| | B | DNA Replication in prokaryotes and eukaryotes (telomere replication). | |
| | C | Semi-conservative, bidirectional and semi-discontinuous replication | |
| | **Unit 4** | **Transcription and Post Transcriptional Modifications** | CO4, CO6 |
| | A | RNA polymerase and mechanism of transcription in prokaryotes and eukaryotes | |
| | B | Concept of introns and exons, splicing mechanism | |
| | C | Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements | |
| | **Unit 5** | **Translation and Gene regulation** | CO5, CO6 |
| | A | Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; | |
| | B | Process of protein synthesis in prokaryotes. | |
| | C | Gene regulation: lac operon and trp operon; | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Cooper G.M., and Hausman R.E., The Cell: A Molecular Approach, 5th Edition. Sinauer Associates (2009) | |
| | Other References | Karp G., Cell and Molecular Biology: Concepts and Experiments, 6th Edition. Wiley (2009). | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 2 |
| **CO2** | 3 | 2 | 1 | - | 1 | - | 1 | - | 3 | - | 3 | 1 | 1 |
| **CO3** | 3 | 3 | 3 | 1 | 1 | 1 | - | 1 | 3 | 1 | 3 | 2 | 3 |
| **CO4** | 3 | 2 | 1 | 2 | 1 | - | 1 | 1 | 2 | 2 | 2 | 2 | 1 |
| **CO5** | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |
| **CO6** | 3 | 2 | 3 | 2 | 1 | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **Avg** | 3.0 | 2.0 | 1.8 | 1.5 | 1.0 | 1.0 | 1.0 | 1.0 | 2.2 | 1.6 | 2.8 | 1.7 | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI111** **Course Title: Principles of Bioinstrumentation**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** | |
| **Branch: Biotechnology** | | **SEMESTER: II$^{nd}$** | |
| **1** | Course Code | **BBI111** | |
| **2** | Course Title | **Principles of Bioinstrumentation** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | To get a brief idea about different instruments commonly use in the biotech laboratories | |
| **6** | Course Outcomes | The student at the completion of the course will be able to:<br>CO1: Define the concept of biosafety and principle of microscopy<br>CO2: Illustrate brief idea about common biotech lab instruments<br>CO3: Construct the principle of centrifugation and different types of centrifuges<br>CO4: Analyze basic principle of chromatography and discuss different types of chromatographic techniques<br>CO5: Evaluate different types of electrophoresis and understand the principle of PCR and DNA sequencing.<br>CO6: Develop the understanding of biological instruments and techniques. | |
| **7.** | Course Description | Bioinstrumentation is the development of technologies for the measurement and manipulation of parameters within biological systems, focusing on the application of engineering tools for scientific discovery | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Laboratory Techniques** | CO1,CO6 |
| | A | Biosafety in microbiological laboratories: General safety measures, Personal protection, chemical and Biological hazards, Spillage and Waste disposal, First aid. | |
| | B | Principle and uses of microscope - compound microscopy, phase contrast microscopy | |
| | C | Theory, principle, uses of centrifuge. | |
| | **Unit 2** | **Chromatographic Techniques** | CO2, CO6 |
| | A | Theory, Principle, Apparatus, Methods and Applications of Paper Chromatography, TLC, HPTLC | |
| | B | Gel Filtration Chromatography, Ion Exchange Chromatography | |
| | C | Affinity Chromatography, Gas Chromatography, HPLC and types of Columns used in HPLC. | |
| | **Unit 3** | **Centrifugation** | CO3, CO6 |

| | | | |
|---|---|---|---|
| | A | Principle of centrifugation, different types of centrifuge and rotors. | |
| | B | Types of rotor: fixed angle and swinging bucket rotors, Bench top and high-speed centrifuges | |
| | C | Preparative, differential and density gradient centrifugation, Analytical centrifugation | |
| | **Unit 4** | **Spectroscopy** | CO4, CO6 |
| | A | Concept of electromagnetic radiation, principle and uses of spectrophotometer | |
| | B | Types of spectroscopies- absorption spectroscopy, emission spectroscopy, scattering spectroscopy | |
| | C | UV/VIS absorption spectroscopy, IR spectroscopy, Circular dichroism, Raman spectroscopy | |
| | **Unit 5** | **Electrophoresis and PCR** | CO5, CO6 |
| | A | Electrophoresis – principle and working of Gel Electrophoresis; Immunoelectrophoresis, isoelectric focusing | |
| | B | Capillary electrophoresis, 2D electrophoresis, Pulse field electrophoresis, | |
| | C | Polymerase Chain Reaction (PCR), DNA sequencing (Sanger's Dideoxy method) | |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Alka Gupta. Instrumentation &Bioanalytical Techniques. Pragati Edition | |
| | Other References | Subramanian M A. Biophysics: Principles and Techniques. MJP Publishers Ltd.<br>Cottenil, R M S. Biophysics: An Introduction. John Wiley& Sons Ltd, England, 2002 | |

**CO-PO-PSO Mapping**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | **1** | **1** | 1 | 1 | 1 | **1** | **3** | **3** | 3 | 2 |
| **CO2** | 3 | 3 | 3 | **2** | 1 | **1** | 1 | **1** | 3 | - | 3 | 3 | 1 |
| **CO3** | 3 | 3 | 3 | 1 | 1 | 1 | **1** | **2** | **1** | **1** | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 1 | **1** | 1 | **1** | **3** | **2** | **1** | - | **3** | 3 | 1 |
| **CO5** | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 2 |
| **CO6** | 3 | 3 | 3 | **2** | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 1 | 3 |
| **Avg** | 3.0 | 2.5 | 2.5 | 1.3 | 1.0 | 1.2 | 1.3 | 1.3 | 1.7 | 1.8 | 3.0 | 2.3 | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI112** **Course Title: Basics of Cell and Molecular Biology Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** |
| **Branch: Biotechnology** | | **SEMESTER: II$^{nd}$** |
| **1** | Course Code | **BBI112** |
| **2** | Course Title | **Basics of Cell and Molecular Biology Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | Compulsory |
| **5** | Course Objective | To understand how cell is to maintain life. |
| **6** | Course Outcomes | After finishing the course, the students will be able to:<br>CO1: Demonstrate safe laboratory practices and handle the equipment safely.<br>CO2: Study the structure of the cells.<br>CO3: Study mitosis and meiosis<br>CO4: Gene amplification<br>CO5: Construct a phylogenetic tree,<br>CO6: To understand the concept of cell and molecular biology basic techniques |
| **7.** | Course Description | In this laboratory, Students will investigate the principles of molecular and cellular biology and practice using the scientific method to explore biological processes. They will make observations, formulate own hypotheses, collect data, and analyze data to draw conclusions. |

| 7. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Laboratory Practices** | |
| | A | Good lab practices in molecular biology laboratory | CO1, CO6 |
| | B | Pipetting: introduction care, and precautions | CO1, CO6 |
| | C | Preparation of standard solutions for molecular biology experiments | CO1, CO6 |
| | **Unit 2** | **Study cell structure** | |
| | A | To study cell structure from onion leaf peels | CO2, CO6 |
| | B | To study cell structure from cheek cells | CO2, CO6 |
| | C | To study cell structure from stem | CO2, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | **Unit 3** | **Mitosis and Meiosis** | | | |
| | A | To study the different stages of Mitosis in root tip of onion. | | | CO3, CO6 |
| | B | To study the different stages of Meiosis in grasshopper testis | | | CO3, CO6 |
| | C | Viva and record | | | CO3, CO6 |
| | **Unit 4** | **Bacterial DNA** | | | |
| | A | To isolate DNA from bacterial cells | | | CO4, CO6 |
| | B | 16S rRNA gene amplification – PCR | | | CO4, CO6 |
| | C | Gel Electrophoresis to confirm the amplification | | | CO4, CO6 |
| | **Unit 5** | **Bioinformatics Tools** | | | |
| | A | Introduction to BLAST Tool | | | CO5, CO6 |
| | B | Sequence similarity search with freely available tools | | | CO5, CO6 |
| | C | Construction of phylogenetic tree | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | Michael, R. G., Sambrook. J., "Molecular Cloning-A Laboratory Manual", 4th edition, Cold Spring Harbor Laboratory Press, 2012.Laboratory Press, 2012. | | | |
| | Reference books | Chard, T., Work, T. S., & Work, E. (1987). Laboratory techniques in biochemistry and molecular biology. Elsevier, Amsterdam. | | | |

**CO-PO-PSO Mapping**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 3 | 1 | - | - | - | 1 | - | - | 1 | 1 | 1 |
| **CO2** | 3 | 3 | 3 | **2** | 1 | 1 | - | 1 | - | - | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | - | - | 1 | 1 | - | - | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | - | 1 | - | - | - | - | 3 | 2 | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 3 |
| **CO6** | 3 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 3 |
| **Avg** | 2.7 | 2.8 | 3.0 | 1.8 | 1.3 | 1.3 | 1.3 | 1.0 | 1.5 | 2.0 | 2.7 | 1.8 | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI113 Course Title: Principles of Bioinstrumentation Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** |
| **Branch: Biotechnology** | | **SEMESTER: II$^{nd}$** |
| **1** | Course Code | **BBI113** |
| **2** | Course Title | **Principles of Bioinstrumentation Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | Compulsory |
| **5** | Course Objective | This course is designed to make students learn about various instruments and techniques of biotechnology laboratory and will also enable them to use and apply these techniques and equipment to solve experimental problems |
| **6** | Course Outcomes | After finishing the course, the students will be able to:<br>CO1: The conceptual understanding of autoclave and how to operate it<br>CO2: Able to operate basic instruments in the lab<br>CO3: Separate and visualize nucleic acids using gel electrophoresis<br>CO4: Operate spectrophotometer and perform absorbance assays<br>CO5: Able to understand the concept of chromatography technique<br>CO6: To learn the operation and working of different instruments and bioanalytical techniques |
| **7** | Course Description | To make students learn the working and operation of various biotechnological instruments. |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Practical based on Sterilization** | |
| | A | To learn the working of an autoclave. | CO1, CO6 |
| | B | To learn the working of a laminar air flow. | CO1,CO6 |
| | C | To sterilize glassware using hot air oven. | CO1,CO6 |
| | **Unit 2** | **Laboratory Instruments** | |
| | A | Working and principle of pH meter | CO2, CO6 |
| | B | Working and principle of incubator shaker | CO2, CO6 |
| | C | Working and principle of refrigerated centrifuges | CO2, CO6 |
| | **Unit 3** | **Practical related to gel-electrophoresis** | |

| | | | |
|---|---|---|---|
| | A | Concept and working of electrophoresis | CO3, CO6 |
| | B | Separation of DNA | CO3, CO6 |
| | C | Separation of proteins using PAGE | CO3, CO6 |
| | **Unit 4** | **Practical related to spectrophotometers** | |
| | A | Principle and working of a spectrophotometer | CO4, CO6 |
| | B | Demonstration of spectrophotometer | CO4, CO6 |
| | C | Measuring concentration of protein/DNA using spectrophotometer | CO4, CO6 |
| | **Unit 5** | **Practical related to chromatography** | |
| | A | Chromatography: Principle and working | CO5, CO6 |
| | B | Use of paper chromatography for separation of plant pigments | CO5, CO6 |
| | C | Introduction, working and principle of High Performance Liquid Chromatography | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | |
| | Weightage Distribution | CA: 25% / CE: 25% / ESE: 50% | |
| | Text books | Wilson K.and Walker., "Principles and Techniques of Biochemistry and Molecular Biology", Cambridge Press, 2010. | |
| | Reference books | Cottenil R.M.S., "Biophysics: An Introduction", John Wiley and Sons, 2002.<br>Gupta A., "Instrumentation and Bioanalytical Techniques", Pragati Prakashan, 2009. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 1 | - | - | - | 1 | - | - | 1 | 1 | 1 |
| **CO2** | 3 | 3 | 3 | 3 | 1 | 1 | - | 1 | - | - | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 1 | - | - | 1 | 1 | - | - | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | - | 1 | - | - | - | - | 3 | 2 | 1 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 2 |
| **CO6** | 3 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 2 |
| **Avg** | 2.8 | 2.8 | 3.0 | 1.7 | 1.3 | 1.3 | 1.3 | 1.0 | 1.5 | 2.0 | 2.7 | 1.8 | 1.7 |

***1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)***

**Course code: PHR101** **Course Title: Introduction to Renewable energy and management**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-2027** |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-2024** |
| **Branch: Biotechnology** | | **SEMESTER: II$^{nd}$** |
| 1 | Course Code | **PHR101** |
| 2 | Course Title | **Introduction to Renewable energy and management** |
| 3 | Credits | 3 |
| 4 | (L-T-P) | 3-0-0 |
| 5 | Course Status | Minor Elective |
| 6 | Max. Marks | 15+10+75 = 100 |
| 7 | Min. Marks | |
| 8 | Course Objective | 1. To familiarize the concept of energy and its classification.<br>2. To know the importance of renewable energy.<br>3. To provide the awareness about climate change.<br>4. To familiarize with various renewable energy resources and its management. |
| 9 | Course Outcomes | After the completion of this course, the student will be able to:<br>CO1: comprehend the different types of energy.<br>CO2: examine the importance of fossil fuels and renewable energy resources.<br>CO3: apply the concept of greenhouse effect for climate change.<br>CO4: inculcate the knowledge of renewable energy resources to obtain clean energy and its environmental impact.<br>CO5: familiarize with energy management and sustainable development.<br>CO6: asses the importance of various renewable energy resources and their impacts. |
| 10 | Course Description | This course deals with different types of energy and their impact on the climate change. In this course, the students will learn about the energy management and sustainable energy development. |

| | | | |
|---|---|---|---|
| 11 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Energy and its classification** | |
| | A | Introduction to energy: Definition and units of energy and power. | CO1, CO2 |
| | B and C | Forms of energy and conservation of energy. Fossil fuels, renewable and non-renewable energy & their types. Conventional and non-conventional energy. | CO1, CO2 |
| | **Unit 2** | **Fossil fuels and Alternate Sources of Energy** | |
| | A | Fossil Fuels - Types, Uses, Advantages & Disadvantages, need of renewable energy. | CO1, CO3 |

| | | | |
|---|---|---|---|
| | B and C | An overview of renewable energy resources: solar energy, wind energy, hydroelectric energy, wave energy, ocean thermal energy, tidal energy, geothermal energy and biomass energy. | CO1, CO3 |
| | **Unit 3** | **Climate Change** | |
| | A | Greenhouse gases (GHG) types and sources. The greenhouse effect. | CO1, CO3 |
| | B and C | The link between energy and climate change. Climate change – causes and consequences. global warming. | CO3, CO6 |
| | **Unit 4** | **Renewable energy resources** | |
| | A | Various renewable energy resources- Introduction, availability, classification, relative merits and demerits. | CO4, CO6 |
| | B and C | Social, economic and environmental impacts of renewable energy resources. | CO4, CO6 |
| | **Unit 5** | **Energy Management** | |
| | A | Principles of Energy Management, energy needs of growing economy, energy conservation and its importance. | CO5, CO6 |
| | B and C | Concept of sustainability; Renewable energy for sustainable development. | CO5 ,CO6 |
| | Mode of examination | 20 marks for Test / Quiz / Assignment / Presentation.<br>05 marks for Class Interaction | |
| | Weightage Distribution | CA+MSE \| \| ESE | |
| | | 15% \| \| 75% | |
| | Text book/s | 1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi<br>2. Solar energy - M P Agarwal - S Chand and Co. Ltd.<br>3. Solar energy - Suhas P Sukhative Tata McGraw Hill Publishing Company Ltd.<br>4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004,<br>5. Oxford University Press, in association with The Open University.<br>6. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009 | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | - | - | - | 3 | 1 | - | 1 | - | - | - | - |
| **CO2** | 3 | 1 | - | - | - | 3 | 1 | - | 1 | - | - | - | - |
| **CO3** | 2 | 2 | 1 | - | - | 3 | 1 | - | 1 | - | - | - | - |
| **CO4** | 2 | 2 | 2 | - | - | 3 | 2 | - | 1 | - | - | - | - |
| **CO5** | 1 | 2 | 2 | - | - | 3 | 1 | - | 2 | - | - | - | - |
| **CO6** | 1 | 2 | 2 | - | - | 3 | 2 | - | 2 | - | - | - | - |
| **Avg** | 1.7 | 1.7 | 1.8 | - | - | 3.0 | 1.3 | - | 1.3 | - | - | - | - |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

**Course code: VOL102** **Course Title: Essential Techniques in Life Sciences-2**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-24** |
| **Branch: Biotechnology** | | **SEMESTER: II$^{nd}$** |
| **1** | Course Code | **VOL102** |
| **2** | Course Title | **Essential Techniques in Life Sciences-2** |
| **3** | Credits | **3** |
| **4** | Contact Hours (L-T-P) | **0-0-6** |
| | Course Status | Compulsory |
| **5** | Course Objective | Develop knowledge of a specific area of specialization.<br>Develop research skills especially in biological experiments, project writing andoral presentation. |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>**CO1:** Define the protein concentration using Lowry method.<br>**CO2:** Demonstrate the Electrophoresis technique<br>**CO3:** Identify and amplify the DNA using a thermocycler.<br>**CO4:** Examine the organic and inorganic solutes in the water<br>**CO5:** Assess and able to isolate the bacteria from the milk products<br>**CO6:** Estimate the digested DNA using DNA ligase. |
| **7.** | Course Description | Vocational education is concerned with the training on vocation. It is related to productivity. Vocational education prepares individuals for jobs. It has adequate employment potentialities. It helps in broadening of horizon. It leads to dignity of labour. It is helpful in the maximum utilization of the material resources of the country |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Biomolecules** | |
| | A | To estimate the protein concentration using Lowry method. | CO1, CO6 |
| | B | To estimate the DNA concentration using spectrophotometry method | CO1,CO 6 |
| | C | To calculate the carbohydrate concentration using Molisch Test | CO1,CO 6 |

| | | | | | |
|---|---|---|---|---|---|
| | **Unit 2** | **Isolation of Microbes** | | | |
| | A | Media Preparation and autoclave | | | CO2, CO6 |
| | B | Isolation of algae from soil | | | CO2, CO6 |
| | C | Isolation of fungi | | | CO2, CO6 |
| | **Unit 3** | **PCR** | | | |
| | A | Understand the working of Thermocycler | | | CO3, CO6 |
| | B | To amplify the gene using a thermocycler. | | | CO3, CO6 |
| | C | To purify DNA from an agarose gel | | | |
| | **Unit 4** | **Water Microbiology** | | | |
| | A | Determination of total dissolved oxygen of water | | | CO4, CO6 |
| | B | Determination of chemical oxygen demand (COD) of water | | | CO4, CO6 |
| | C | Determination of biochemical oxygen demand (BOD) of water | | | CO4, CO6 |
| | **Unit 5** | **Isolation of Bacteria** | | | |
| | A | Media preparation and autoclave | | | CO5, CO6 |
| | B | Isolation of Bacteria from milk | | | CO5, CO6 |
| | C | Gram staining | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | Experiments in Microbiology, plant pathology and Biotechnology, K R Aneja | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | 2 | 1 | 1 | - | - | - | 1 | - | - | 1 | 1 | 1 |
| **CO2** | 3 | 3 | 3 | 1 | 1 | 1 | - | 1 | - | - | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 1 | - | - | 1 | 1 | - | - | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 2 | 1 | - | 1 | - | - | - | - | 3 | 2 | 1 |
| **CO5** | 3 | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 3 |
| **CO6** | 3 | 3 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 3 |
| **Avg** | 1.4 | 2.8 | 2.0 | 1.0 | 1.3 | 1.3 | 1.3 | 1.0 | 1.5 | 2.0 | 2.7 | 1.8 | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

| School: SSBSR | | Batch: 2023-2027<br>Current Academic Year: 2023-2024<br>Semester: II | |
|---|---|---|---|
| 1 | Course Code | **ARP102** | |
| 2 | Course Title | Communicative English -2 | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P) | 1-0-2 | |
| 5 | Course Objective | To Develop LSRW skills through audio-visual language acquirement, creative writing, advanced speech et al and MTI Reduction with the aid of certain tools like texts, movies, long and short essays. | |
| 6 | Course Outcomes | After completion of this course, students will be able to:<br><br>CO1 Acquire Vision, Goals and Strategies through Audio-visual Language Texts<br>CO2 Synthesize complex concepts and present them in creative writing<br>CO3 Develop MTI Reduction/Neutral Accent through Classroom Sessions & Practice<br>CO4 Determine their role in achieving team success through defining strategies for effective communication with different people<br>CO5 Realize their potentials as human beings and conduct themselves properly in the ways of world.<br>CO6 Acquire satisfactory competency in use of Quantitative aptitude and Logical Reasoning | |
| 7 | Course Description | The course takes the learnings from the previous semester to an advanced level of language learning and self-comprehension through the introduction of audio-visual aids as language enablers. It also leads learners to an advanced level of writing, reading, listening and speaking abilities, while also reducing the usage of L1 to minimal in order to increase the employability chances. | |
| 8 | Outline syllabus – ARP 102 | | |
| | **Unit 1** | **Acquiring Vision, Goals and Strategies through Audio-visual Language Texts** | **CO Mapping** |
| | A | Pursuit of Happiness / Goal Setting & Value Proposition in life | CO1 |
| | B | 12 Angry Men / Ethics & Principles | |
| | C | The King's Speech / Mission statement in life \| strategies & Action Plans in Life | |
| | **Unit 2** | **Creative Writing** | |
| | A | Story Reconstruction - Positive Thinking | CO2 |
| | B | Theme based Story Writing - Positive attitude | |
| | C | Learning Diary Learning Log – Self-introspection | |
| | **Unit 3** | **Writing Skills 1** | |
| | A | Precis | CO2 |
| | B | Paraphrasing | |
| | C | Essays (Simple essays) | |
| | **Unit 4** | **MTI Reduction/Neutral Accent through Classroom Sessions & Practice** | |

| | | | |
|---|---|---|---|
| | A | Vowel, Consonant, sound correction, speech sounds, Monothongs, Dipthongs and Tripthongs | CO3 |
| | B | Vowel Sound drills , Consonant Sound drills, Affricates and Fricative Sounds | |
| | C | Speech Sounds \| Speech Music\| Tone \| Volume\| Diction \|Syntax \|Intonation \| Syllable Stress \| | |
| | **Unit 5** | **Gauging MTI Reduction Effectiveness through Free Speech** | |
| | A | Jam sessions | CO3 |
| | B | Extempore | |
| | C | Situation-based Role Play | |
| | **Unit 6** | **Leadership and Management Skills** | |
| | A | Innovative Leadership and Design Thinking | CO4 |
| | B | Ethics and Integrity | CO4 |
| | **Unit 7** | **Universal Human Values** | |
| | A | Love & Compassion, Non-Violence & Truth | CO5 |
| | B | Righteousness, Peace | CO5 |
| | C | Service, Renunciation (Sacrifice) | CO5 |
| | **Unit 8** | **Introduction to Quantitative aptitude & Logical Reasoning** | |
| | A | Analytical Reasoning & Puzzle Solving | CO6 |
| | B | Number Systems and its Application in Solving Problems | CO6 |
| 9 | Evaluations | *Class Assignments/Free Speech Exercises / JAM Group Presentations/Problem Solving Scenarios/GD/Simulations ( 60% CA and 40% ESE* | *N/A* |
| 10 | Texts & References \| Library Links | • Wren, P.C.&Martin H. *High English Grammar and Composition*, S.Chand& Company Ltd, New Delhi.<br>• Blum, M. Rosen. *How to Build Better Vocabulary*. London:<br>• Comfort, Jeremy(et.al). *Speaking Effectively*. Cambridge University Press.The Luncheon by W.Somerset Maugham - http://mistera.co.nf/files/sm_luncheon.pdf | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO2** | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| **CO3** | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| **CO4** | - | - | - | - | - | - | - | - | 3 | - | - | - | - |
| **CO5** | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - |
| **CO6** | - | - | - | - | - | - | - | - | 2 | 1 | - | - | - |
| **Avg** | - | - | - | - | - | - | - | - | 2.4 | 2.0 | - | - | - |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

| School: SSHSS | | Semester – 1 | ACADEMIC SESSION: | FOR VAC – 1 Practical |
|---|---|---|---|---|
| 1 | Course code | VAC110 | | |
| 2 | Course Title | Yoga for Holistic health | | |
| 3 | Credits | 3 | | |
| 4 | Learning Hours | 0-1-4 | | |
| 5 | Course Objective | To make the students familiar with the different practices of yoga, chanting and meditation techniques and learn the correct teaching skills. | | |
| 6 | Course Outcomes | 1. To make the students understand the concept of health and wellness through Yoga<br>2. To define the concept and principles of Yoga.<br>3. To interpret and understand the breathing practice.<br>4. To describe the knowledge about Yoga, its foundations and applications to the aspirants.<br>5. To make students aware of Yogic impact on the positive health and personality development.<br>6. The students will learn primary level of Yoga practices, which will groom their personality. | | |
| **7.1** | | **Unit A** | **Importance of Health, Wellness through Yoga** | **CO mapping** |
| 7.11 | | Unit A Topic 1 | Meaning, Definition, Aim of Yoga; Concept of health according to WHO and Ayurveda | CO1, CO2, CO4, CO5, CO6 |
| 7.12 | | Unit A Topic 2 | Misconception about Yoga, Difference between asana and physical exercise | CO1, CO2, CO4, CO5, CO6 |
| 7.13 | | Unit A Topic 3 | Need, Importance of Yoga in health and wellness | CO1, CO2, CO4, CO5, CO6 |
| **7.2** | | **Unit B** | **Schools of Yoga, Modern and Ancient schools of Yoga existing in India, Yogic diet, Yogic attitudes, Sadhak tatva & Badhak tatva** | |
| 7.21 | | Unit B Topic 1 | Schools/ Streams of Yoga – Ashtanga Yoga, Bhakti Yoga, Karma Yoga, Jnana Yoga | CO3, CO4, CO5, CO6 |
| 7.22 | | Unit B Topic 2 | Modern and ancient schools of Yoga existing in India – Natha Sampradaya, Kaivalyadhama, Bihar School of Yoga, Munger, Pragya Yoga (Shantikunj), Iyengar Yoga, Patanjali Yoga Peeth, Ashtanga Vinyasa Yoga | CO3, CO4, CO5, CO6 |

| | | | | |
|---|---|---|---|---|
| 7.23 | | Unit B Topic 3 | Yoga Ahaara (Yogic diet), Yogic Attitudes – Maitri Karuna, Mudita, Upeksha, Sadhak Tatva Badhak Tatva (facilitating/helping factors and obstacles in Yoga sadhana) | CO3, CO4, CO5, CO6 |
| **7.3** | | **Unit C** | **Beginner level practices – Sukshma Vyayama and Surya Namaskara** | |
| 7.31 | | Unit C Topic 1 | Sukshma Vyayama and their benefits for health Part-1 (Bihar School of Yoga) Part-1 | CO4, CO5, CO6 |
| 7.32 | | Unit C Topic 2 | Sukshma Vyayama & their benefits for health (Swami Dhirendra Brahmachari) Part-1 | CO4, CO5, CO6 |
| 7.33 | | Unit C Topic 3 | Surya Namaskara (Sun Salutation) with mantra chanting (12 steps) & their benefits for health | CO4, CO5, CO6 |
| **7.4** | | **Unit D** | **Asana - all categories** | |
| 7.41 | | Unit D Topic 1 | Standing & Sitting - Tadasana, Vrikshasana, Katichakrasana, Padmasana, Vajrasana, Ushtrasana, Paschimottanasana, Vakrasana | CO4, CO5, CO6 |
| 7.42 | | Unit D Topic 2 | Supine and Prone: Uttanapadasana, Pawanamuktasana, Shalabhasana, Bhujangasana | CO4, CO5, CO6 |
| 7.43 | | Unit D Topic 3 | Balancing and Inverted: Trivikramasana, Sarvangasana, Viparitakarani mudra | CO4, CO5, CO6 |
| 7.5 | | Unit E | **Pre-practices of Pranayama, Pranayama and Dhyana** | |
| 7.51 | | Unit E Topic 1 | Kapalabhati, Mukha dhauti, Vibhagiya pranayama (Sectional breathing) | CO1, CO4, CO5, CO6 |
| 7.52 | | Unit E Topic 2 | Anuloma – Viloma, Bhastrika, Shitali | CO1, CO4, CO5, CO6 |
| 7.53 | | Unit E Topic 3 | Om Dhyana, Aanapaanasati Dhyana (breath meditation) | CO1, CO4, CO5, CO6 |
| **8** | **Course Evaluation** | | | |

| | | |
|---|---|---|
| 8.1 | Course work: | |
| 8.11 | Attendance | |
| 8.12 | Homework | Three best out of five assignments: 10 marks |
| 8.13 | Quizzes | Three best out of five tests: 10 marks |
| 8.14 | Projects | None |
| 8.15 | Presentations | One best out of two: 10 marks |
| 8.2 | CA: 60 % Practical | |
| 8.3 | End-term examination: 40% Viva | |
| **9** | **References** | |
| 9.1 | Text book | 1. Sri Ananda: The Complete book of Yoga, Orient Course Backs, Delhi, 2003.<br>2. Basavaraddi, I.V. & other: SHATKARMA: A Comprehensivedescription about Cleansing Process, MDNIY New Delhi, 2009<br>3. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009<br>4. Dr. Nagendra H R: Pranayama, The Art & Science, Swami Vivekananda Yoga Prakashan, Bangalore, 2005.<br>5. Swami Niranjanananda Saraswati: Asana Pranayama Mudra Bandha, Yoga Publication Trust, Munger Bihar.<br>6. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009<br>7. Swami Kuvalyananda: Pranayama, Kaivalyadhama, Lonavla, 2010<br>8. Swami Rama: Science of Breath, A Practical Guide, The Himalayan International Institute, Pennselvenia, 1998.<br>9. Swami Niranjanananda Saraswati: Prana, Pranayama & Pranavidya, Yoga Publications Trust, Munger, Bihar, 2005 |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | - | - | - | 3 | - | - | - | - |
| **CO2** | - | - | - | - | - | - | - | - | 3 | - | - | - | - |
| **CO3** | - | - | - | - | - | - | - | - | 3 | - | - | - | - |
| **CO4** | - | - | - | - | - | - | - | - | 3 | - | - | - | - |
| **CO5** | - | - | - | - | - | - | - | - | 3 | - | - | - | - |
| **CO6** | - | - | - | - | - | - | - | - | 3 | - | - | - | - |
| **Avg** | - | - | - | - | - | - | - | - | 3.0 | - | - | - | - |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

# SEMESTER III

**Course code: BBT209** **Course Title: Genetics**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-2025** | |
| **Branch: Biotechnology** | | **SEMESTER: III$^{rd}$** | |
| **1** | Course Code | **BBT209** | |
| **2** | Course Title | **Genetics** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1.This course has been designed to make students understand the basic principles of classical Mendelian Genetics<br>2. To know about modern basis of heredity and to understand the transmission of characters via non-nuclear genes and effect of mutations on transmission of characters<br>3. Students understand the fine structure of gene and classical experiments that lead to the development of gene fine structure and its function | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Define Mendelian laws and their exceptions or amendments<br>CO2: Describe the structure of DNA, chromosomes and aberrations in chromosomes<br>CO3: Demonstrate the extra nuclear inheritance with suitable examples<br>CO4: Compare different types of mutation and its consequences<br>CO5: Appraise different experiments which define the structure and function of gene<br>CO6: Collaborate the basic principles of genetics, gene mutations and mechanisms of inheritance and heredity | |
| | Course Description: | The 'Genetics' course outlines the basic principles of Classical Genetics. This course also sheds light upon modern genetics and is designed to make student learn the structure of chromosomes; nucleosomal organization of genetic material etc to understand the basis of heredity. The course also further encompasses the concept of mutation; extra nuclear inheritance of characters and effect of these phenomena on transmission of characters. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Mendalism and Human Genetics** | CO1,CO6 |
| | A | Brief overview of Mendel's work; monohybrid and di-hybrid crosses; Mendel's Law of segregation & Law of independent assortment, Verification of segregates by back and test crosses; | |
| | B | Allelic interactions: Concept of dominance, recessive, incomplete dominance, co-dominance, semi-dominance, multiple alleles, pseudo-allele, essential and lethal genes | |
| | C | Non allelic interactions: epistasis (dominant & recessive), duplicate genes. | |
| | **Unit 2** | **Physical basis of Inheritance** | CO2, CO6 |

| | | | |
|---|---|---|---|
| | A | Chromosome theory of inheritance; Eukaryotic Chromosome: Macromolecular Organization; packaging of DNA molecule into chromosomes | |
| | B | Heterochromatin and Chromatin and its significance, karyotype; Chromosome types, primary and secondary constrictions; Centromere and Telomeres | |
| | C | Variation in chromosome number Aneuploidy and Euploidy; | |
| | **Unit 3** | **Linkage and Crossing Over and Sex Determination and Dosage compensation** | CO3, CO6 |
| | A | Concept of linkage and crossing over; Coupling and repulsion hypothesis; Linkage in maize and Drosophila | |
| | B | Extrachromosomal Inheritance: Maternal Inheritance: shell coiling in Limnaea; Inheritance of Mitochondrial DNA and Mitochondrial diseases in Human; Inheritance of Chloroplast DNA and Cytoplasmic Male Sterility (CMS) in crop plants; sex Determination- in humans, Drosophila and other animals; | |
| | C | Dosage compensation of X-linked genes– hyperactivation of X-linked gene in male Drosophila inactivation of X-linked genes in female mammals | |
| | **Unit 4** | **Mutation and cancer** | CO4, CO6 |
| | A | Definition and types of mutations, Molecular basis of Mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants | |
| | B | Mutation in chromosomes: deletion, duplication, inversion and translocation. | |
| | C | Oncogenes- tumor inducing retroviruses and viral Oncogenes; Chromosome rearrangement and cancer | |
| | **Unit 5** | **Fine Structure of Gene** | CO5, CO6 |
| | A | Benzer and T4 rII locus, Complementation test; | |
| | B | Cistron, recon and muton Beadle and Tatum's one gene one enzyme concept | |
| | C | One gene one polypeptide concept | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Hartl D.L. and Jones E.W, "Genetics: analysis of genes and genomes". Edition 5. Jones and Bartlett Publishers, 2000. | |
| | Other References | Gardner E.J., Simmons M.J., Snustad M.J., "Principles of genetics". Edition 8. John Wiley & Sons (Asia) Pt. Ltd., 2007. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | - | 1 | - | 2 | 2 | 1 | 1 | 2 | 3 | 2 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 1 | 3 | 3 | 2 |
| CO3 | 3 | 1 | 1 | - | 1 | - | 2 | 2 | 1 | 2 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 1 | - | 1 | - | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | - | 1 | - | 2 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO6 | 3 | 2 | 2 | - | 1 | - | 3 | 2 | 2 | 1 | 3 | 3 | 1 |
| Avg | 3.0 | 1.7 | 1.5 | - | 1.0 | - | 2.2 | 1.8 | 1.3 | 1.5 | 2.8 | 2.7 | 1.5 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI201** **Course Title: Basic Immunology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-2025** | |
| **Branch: Biotechnology** | | **SEMESTER: III** | |
| **1** | Course Code | **BBI201** | |
| **2** | Course Title | **Basic Immunology** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1. Understand the concepts of immune system, immunity, immune responses, cells and organs of immune system<br>2. Describe about antigens, antibodies and their types & properties, qualitative and quantitative analysis of antigens or antibodies for diagnostic purposes, role of molecules like MHC and cytokines in generation of immune response<br>3. Explore immunology as a basic toll for medical applications | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Understand immune system, immunity and immune response.<br>CO2: Describe cells and organs of immune system.<br>CO3: Illustrate about antigens, antibodies and their types & properties.<br>CO4: Demonstrate the qualitative and quantitative analysis of antigens or antibodies for diagnostic purposes.<br>CO5: Identify the role of molecules like MHC and cytokines in generation of immune response.<br>CO6: Explore immunology as a basic tool for medical applications. | |
| | **Course Description** | This course will cover the major topics in Immunology, including immune system, lines of defense, immunity, immune response, cells and organs of immune system, "antigens, antibodies and their types & properties", qualitative and quantitative analysis of antigens or antibodies for diagnostic purposes, "role of molecules like MHC and cytokines in generation of immune response". | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Cells and organs of immune system** | CO1,CO6 |
| | A | Primary and secondary lymphoid organs, their structure and function | |
| | B | Cells of immune system; hematopoiesis and Differentiation | |
| | C | Structure and role of B and T lymphocytes, NK cells, macrophages, Dendritic cells, mast cells, eosinophil's, basophils and neutrophils | |
| | **Unit 2** | **Immune Responses and Effector Mechanism** | CO2, CO6 |
| | A | Innate and adaptive immunity, humoral and cell mediated immune response; Lines of defense and various barriers; Clonal nature of immune response, | |

| | | | |
|---|---|---|---|
| | B | Signaling through immune system receptors- antigen receptor, structure and signaling pathways. | |
| | C | Regulation of immune response | |
| | **Unit 3** | **Antigen and Antibody** | CO3, CO6 |
| | A | Antigen and Immunogen, antigenicity vs immunogenicity, properties of antigens | |
| | B | Antibody molecule, types and structure; Role in immune response | |
| | C | Types of hypersensitivity | |
| | **Unit 4** | **Antigen Antibody Interaction and MHC molecule** | CO4, CO6 |
| | A | Antigen antibody interaction: Immunodiffusion (Double and radial) RIA & ELISA; Immunoelectrophoresis. | |
| | B | MHC molecule and its types, structure and their function; | |
| | C | Cytokines and their role in immune response | |
| | **Unit 5** | **Immunity in health and disease** | CO5, CO6 |
| | A | Introduction to infectious diseases and immunonological responses; Autoimmunity | |
| | B | Responses to self-antigens, transplant rejection- responses to alloantigens. | |
| | C | Vaccines and diseases; Monoclonal antibody and hybridoma technology | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Kuby Immunology, VII Edition-R.A. Goldsby, Thomas | |
| | Other References | Immunology-A short course,4th Edition-Benjamini, Richard Coico, Geoffrey Sunshine, (Wiley- Liss). | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| CO2 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO3 | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 1 | 2 |
| CO4 | 2 | 2 | 3 | 2 | 1 | 1 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 2 |
| CO6 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 |
| Avg | 2.7 | 1.5 | 1.7 | 1.7 | 1.0 | 1.0 | 2.0 | 2.2 | 1.8 | 1.3 | 2.7 | 2.0 | 1.8 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBT211** **Course Title: Biophysics**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** | |
| **Branch: Biotechnology** | | **SEMESTER: III** | |
| **1** | Course Code | **BBT211** | |
| **2** | Course Title | **Biophysics** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Minor | |
| **5** | Course Objective | 1. To understand the basic concepts involved in the field of research and industrial endeavors.<br>**2.** Biophysics plays a pivotal role in biomedicine, diagnostics and academics fields | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1**:** Identify the basic concepts involved in Biophysics at the molecular & cellular level.<br>CO2**:** Summarize about the crucial concepts and role of pH and buffers<br>CO3**:** Discover the basics of water in biological system<br>CO4**:** Illustrate the concepts of optics<br>CO5: Appraise the concepts of radiation in association with biophysics<br>CO6: Examine the concepts of biophysics that can be used to study biology associated with research, industry, medicine and diagnostics | |
| | **Course Description** | Biophysics broadly concerns trying to understand biology in a quantitative way, using experimental techniques, theories, and concepts developed from different areas of physics such as statistical physics, nonlinear dynamics, polymer physics, mechanics, fluid mechanics, optics, quantum mechanics, and nanoscience. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Physical and chemical aspect of Biology-1** | CO1,CO6 |
| | A | Structure of atom, Bohrs theory, Rutherford experiment, Gold foil experiment | |
| | B | Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipole-induced dipole interactions; London dispersion forces | |
| | C | Bonds within molecules- Ionic, covalent, Electrostatic, Disulphide & peptide bonds, Vander Waals forces, Bond lengths & Bond energies, Bond angles. | |
| | **Unit 2** | **Physical and chemical aspect of Biology-2** | CO2, CO6 |
| | A | Acid & Bases, mole concept, weak acids base, Ampholyte, pH, Calculations of pH from H & OH concentrations | |
| | B | Henderson –Hasselbalch equation, pK values, Buffer, numerical problems | |

| | | | |
|---|---|---|---|
| | C | Redox potential: Oxidation –Reduction, Equivalence of electrical & chemical energy, | |
| | **Unit 3** | **Water properties and Importance** | CO3, CO6 |
| | A | Molecular structure of water, Association of water through H-bonding, Nature of hydrophobic interactions, physicochemical properties of water | |
| | B | The Influence of Ions: Structure-Making and Structure-Breaking, Long-Range Hydrophobic Interactions and the Role of Bubbles, Hydrophilic Surfaces. | |
| | C | Specific Roles of Water in:- Secondary Structure of protein, Protein-Protein Interactions, Mediation of Ligand Binding | |
| | **Unit 4** | **Role of light and its application in biology** | CO4, CO6 |
| | A | Light: Reflection, Refraction, Diffraction, Interference phenomena | |
| | B | Microscope general principle, uses. Polarization, compound, phase contrast, fluorescence microscopy | |
| | C | Electron Microscopy and its types | |
| | **Unit 5** | **Radiation Biophysics** | CO5, CO6 |
| | A | Introduction to Radioactivity, General properties of alpha, beta and gamma radiations, Units of measurement- Curie, Becquerel | |
| | B | Radiolysis of water, Direct and indirect effects of radiation. Effect of radiation on Nucleic acids, Proteins, Enzymes | |
| | C | Radiation sources, Tele-gamma Unit (Cobalt unit), Gamma chamber, Particle Accelerators, Nuclear reactors. Principles of radiation dissection and measurement | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | 1. Subramanian M A. Biophysics: Principles and Techniques. MJP Publishers Ltd. | |
| | Other References | 1. R M S. Biophysics: An Introduction. John Wiley& Sons Ltd, England, 2002.<br>2. Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience: Ken Dill,<br>3. Alka Gupta. Instrumentation & Bioanalytical Techniques. Pragati Edition | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 |
| CO4 | 1 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 |
| CO5 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO6 | 2 | 3 | 2 | **1** | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |
| Avg | 1.7 | 2.7 | 2.2 | 1.0 | 1.0 | 1.0 | 1.7 | 1.7 | 1.5 | 1.2 | 2.0 | 1.7 | 1.2 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI203 Course Title: Physical and Chemical aspects of Biological Sciences**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** | |
| **Branch: Biotechnology** | | **SEMESTER: III** | |
| **1** | Course Code | **BBI203** | |
| **2** | Course Title | **Physical and Chemical aspects of Biological Sciences** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Minor | |
| **5** | Course Objective | Understanding the general properties of vitamins and minerals in the body<br>To understand the physical aspect of biology<br>To understand the chemistry aspect of biology | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Understand the role of vitamins and minerals in human body<br>CO2: Summarize about the crucial concepts of PCR and Sequencing<br>CO3: Discover the role of thermodynamics in human body<br>CO4: Illustrate the concepts of the redox potential and role of ATP<br>CO5: Appraise the concepts of plasma membrane in a cell<br>CO6: Examine the concepts of physics and chemistry in biology. | |
| | **Course Description** | This course comprises of the structure, function, properties and significance of various macromolecules found in biological systems. Several different macromolecules viz. lipids, carbohydrates, amino acids, proteins, and nucleic acids will be studied in details. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Vitamins and micronutrients** | CO1,CO6 |
| | A | Role of micronutrients – vitamins and minerals | |
| | B | Dietary sources, biochemical functions, requirements | |
| | C | Deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins | |
| | **Unit 2** | **PCR and sequencing** | CO2, CO6 |
| | A | Tm of DNA, factors of responsible of denaturation and renaturation of DNA. | |
| | B | Introduction to PCR – Principle and applications | |
| | C | Introduction to sequencing and utility. Maxman Gilbert Sequencing, and Sangers sequencing | |
| | **Unit 3** | **Bioenergetics** | CO3, CO6 |
| | A | Concepts of bioenergetics: Laws of thermodynamics, Gibbs free energy | |
| | B | Enthalpy, Entropy, change in free energy, Standard free energy change pH 7.0 (derivations and numerical) | |
| | C | Biological systems as open, non-equilibrium systems | |

| | | | |
|---|---|---|---|
| | **Unit 4** | **Redox potential** | CO4, CO6 |
| | A | Biological oxidation-reduction reactions, redox potential and its significance | |
| | B | high energy compounds (ATP, GTP) | |
| | C | Reasons for high group transfer potential of ATP including structural basis, ATP hydrolysis and equilibria of coupled reactions. | |
| | **Unit 5** | **Plasma Membrane** | CO5, CO6 |
| | A | Plasma Membrane structure; Membrane lipids; Architecture and composition of bio-membrane, Membrane fluidity – Cholesterol, floppase and flippase | |
| | B | Transport across membranes: Diffusion, Active and Passive transport, Facilitated transport | |
| | C | Cell junctions: Tight junctions, Desmosomes, Gap junctions | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Subramanian M A. Biophysics: Principles and Techniques. MJP Publishers Ltd. | |
| | Other References | R M S. Biophysics: An Introduction. John Wiley& Sons Ltd, England, 2002.<br>Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience: Ken Dill,<br>Alka Gupta. Instrumentation & Bioanalytical Techniques. Pragati Edition | |

**CO-PO-PSO Mapping**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO2** | 2 | 3 | 1 | 1 | 1 | - | 3 | 1 | 1 | 1 | 3 | - | 1 |
| **CO3** | 3 | 1 | 1 | 1 | 1 | - | 1 | 1 | 2 | 2 | 2 | 1 | 1 |
| **CO4** | 3 | 2 | 1 | 1 | 1 | - | 2 | 1 | 1 | 1 | 2 | 2 | 1 |
| **CO5** | 3 | 2 | 1 | 1 | 1 | - | 2 | 1 | 2 | 1 | 1 | - | 1 |
| **CO6** | 3 | 2 | 2 | 1 | 1 | - | 2 | 1 | 2 | 1 | 2 | 2 | 1 |
| **Avg** | 2.7 | 2.2 | 1.3 | 1.0 | 1.0 | - | 1.8 | 1.0 | 1.5 | 1.2 | 1.8 | 1.8 | 1.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: RBL001** **Course Title: Research Based Learning I**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc** | | **Current Academic Year: 2024-25** |
| **Branch: Biotechnology** | | **SEMESTER: III** |
| **1** | Course Code | **RBL001** |
| **2** | Course Title | **Research Based Learning I** |
| **3** | Credits | **Audit based** |
| **4** | Contact Hours (L-T-P) | **0-0-4** |
| | Course Status | Compulsory |
| **5** | Course Objective | Develop knowledge of a specific area of specialization.<br>Develop research skills especially in biological experiments, project writing and oral presentation. |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>**CO1:** Articulate research-based investigation done on a topic<br>**CO2:** Demonstrate capacity to identify theoretical/experimental method followed in the research articles<br>**CO3:** Demonstrate an understanding of the ethical issuesassociated with practitioner research<br>**CO4:** Compare research data and extract the outstandingresults<br>**CO5:** Report research findings in written and verbal forms<br>**CO6:** Use research findings to advance education theory andpractice |
| | **Course Description** | Research-based learning (RBL) aims to promote and develop student compESEncies related to research practice and to benefit students through activities linked to research . This technique implies the application of learning and teaching strategies that link research with teaching |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Introduction to various research problems** | **CO1,CO6** |
| | **Unit 5** | **Identify a research question** | **CO2,CO6** |
| | **Unit 3** | **Literature survey** | **CO3,CO6** |
| | **Unit 4** | **Report writing** | **CO4,CO6** |
| | **Unit 5** | **Presentation** | **CO5 ,CO6** |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | |

| | | | | | |
|---|---|---|---|---|---|
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | 10 Recent International Journal Articles of repute. | | | |
| | Reference books | | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO3 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| CO5 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 2 |
| CO6 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 |
| Avg | 1.5 | 2.0 | 1.5 | 1.8 | 1.2 | 1.0 | 1.7 | 1.8 | 1.8 | 1.2 | 2.3 | 1.7 | 1.7 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course Code: PHR201** **Course Name: Renewable Energy Resources**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-2027** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-2024** | |
| **Branch: Biotechnology** | | **SEMESTER: III** | |
| 1 | Course Code | **PHR201** | |
| 2 | Course Title | **Renewable Energy Resources** | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| 5 | Course Status | Minor Elective | |
| 6 | Max. Marks | 15+10+75=100 | |
| 7 | Min. Marks | | |
| 8 | Course Objective | This course provides an opportunity to develop knowledge and understanding of the key principles and applications of biomass energy and resources | |
| 9 | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Understand and develop knowledge about the different kinds of renewable energy resources.<br>CO2: Analyse the energy consumption (both in rural and urban areas) and energy demand and current Indian energy scene.<br>CO3: Understand the Impact on environmental degradation due to production and utilization of energy.<br>CO4: Understand and Analyse the solar cells<br>CO5: Understand and develop knowledge about the Geothermal, wind, ocean and bioenergy resources.<br>CO6: Students will have deep knowledge about the various renewable resources including solar energy, geothermal energy, wind and ocean energy and adverse effect of energy consumption on environment. | |
| 10 | Course Description | This course provides deep knowledge about the different forms of energy, various renewable resources including solar energy, geothermal energy, wind and ocean energy, solar cells (1st, 2nd, and 3rd generation), and adverse effect of energy consumption on environment. | |
| 11 | Outline syllabus | | CO Mapping |
| | | | |
| | **Unit 1** | **Renewable energy and its Resources** | |

| | | | |
|---|---|---|---|
| | A | Definition, units, and power of energy, Forms of energy, Second law of thermodynamics and conversion of energy, Origin and time scale of fossil fuels. | CO1 |
| | B | Conventional and nonconventional energy sources, Renewable-non-renewable energy resources, Green energy, clean energy (definition and example only), | CO1 |
| | C | Energy resources, coal, oil, natural gas, nuclear and hydroelectric power, Concepts of ecological footprint, green footprint, and carbon footprint. | CO1 |
| | **Unit 2** | **Energy demand, Energy Consumption, and Indian Energy Scene:** | |
| | A | Role of energy in economic development, Energy consumption in various sectors, Exponential increase in energy consumption and its impact on global economy, Energy demand and Energy trilemma index. | CO2 |
| | B | Indian Energy Scene: Energy resources available in India, Urban and rural energy consumption, Nuclear energy (scope and future) variation of energy consumption as a function of energy, | CO2 |
| | C | Need of new renewable resources, National Green Tribunal (NGT) act and activities. | CO2 |
| | **Unit 3** | **Environmental effects on energy consumption** | |
| | A | Environmental degradation due to production and utilization of energy,<br>Impact of environmental degradation activities on biological damage. | CO3 |
| | B | Environmental effects of thermal power stations and nuclear power generation, Air and water pollution, Effect on Ozone layer, Global warming. | CO3 |
| | C | Hydroelectric power, Geothermal power, Energy harvesting (Ocean, wind, solar and bioenergy). | CO3, CO6 |
| | | | |
| | **Unit 4** | **Solar Energy and Solar Cells** | |
| | A | Need of Solar energy, Solar Energy, Solar constant, Solar radiation spectrum | CO4 |
| | B | Classification of solar cells: 1st generation (single vs polycrystalline), 2nd generation, 3rd generation. | CO4, CO6 |
| | C | Key elements of silicon solar cells, PV solar cell, Module, Panel and array, solar thermal system types. Applications of solar thermal systems. | CO4, CO6 |
| | **Unit 5** | **Geothermal, Wind, Ocean and Bioenergy** | |
| | A | Geothermal Energy: Introduction, Geothermal power, Geothermal resources, Advantage and disadvantage of geothermal energy over other form of energy. | CO5 |
| | B | Wind energy: Introduction, Principle of wind energy conversion, Advantage and Disadvantage of wind mills, Application of wind energy. | CO5, , CO6 |
| | C | Ocean Energy: Introduction, Principle of ocean thermal energy conversion, Tidal power generation, tidal energy technologies, Wave energy conversion, Advantages and Disadvantages.<br>Bio Energy: Introduction, Sources of biomass, Advantage and disadvantage of bio energy over other form of energy. | CO5, CO6 |
| | Mode of examination | 20 marks for Test / Quiz / Assignment / Seminar.<br>05 marks for Class Interaction | |

| | | | | | |
|---|---|---|---|---|---|
| | Weightage Distribution | CA | MSE | ESE | |
| | | 15% | 10% | 75% | |
| | Text book/s*<br><br><br><br><br>Reference book/s* | **PART A**<br>1. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle.<br>2. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki<br><br>**PART B**<br><br>1. Physics of Energy Sources, G. C. King<br>2. Physics and Technology of Sustainable Energy; E L Wolf<br>3. Advanced renewable Energy Systems, S C Bhatia 3. D.P.Kothari, K.C Singal and Rakesh Ranjan "Renewable Energy Sources And Emerging Technologies", 2011, PHI Learning Private Ltd, New Delhi. | | | |
| | Suggestive Digital Platforms / Web Links | 1. https://www.edx.org/learn/renewable-energy<br>2. https://www.coursera.org/courses?query=renewable%20energy<br>3. National Programme on Technology Enhanced Learning (NPTEL), https://onlinecourses.nptel.ac.in/noc21_ch11/preview | | | |
| | Suggested Equivalent Online Courses | 1. The Renewable Energy Institute, renewable energy course,<br>2. National Programme on Technology Enhanced Learning (NPTEL), https://onlinecourses.nptel.ac.in/noc21_ch11/preview<br>3. https://onlinecourses.nptel.ac.in/noc22_ph44/preview (swayam course) | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | - | - | 3 | 2 | 1 | 2 | 1 | 2 | - | 1 |
| CO2 | 1 | 3 | 1 | - | - | 3 | 2 | 1 | 1 | 1 | 2 | - | 1 |
| CO3 | 2 | 3 | 2 | - | - | 2 | 2 | 1 | 2 | 2 | 2 | - | 2 |
| CO4 | 2 | 3 | 3 | - | - | 3 | 2 | 1 | 2 | 1 | 2 | - | 2 |
| CO5 | 2 | 1 | 1 | - | - | 3 | 1 | 1 | 2 | 1 | 2 | - | 1 |
| CO6 | 2 | 3 | 2 | - | - | 3 | 1 | 2 | 2 | 1 | 2 | - | 1 |
| Avg | 1.8 | 2.3 | 1.7 | - | - | 2.8 | 1.7 | 1.2 | 1.8 | 1.2 | 2.0 | - | 1.3 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code:** VOL201 **Course Title:** Essential techniques in life Sciences-3

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** |
| **Branch: Biotechnology** | | **SEMESTER: III** |
| **1** | Course Code | VOL201 |
| **2** | Course Title | Essential techniques in life Sciences-3 |
| **3** | Credits | **3** |
| **4** | Contact Hours (L-T-P) | **0-0-6** |
| | Course Status | Compulsory |
| **5** | Course Objective | Develop knowledge of a specific area of specialization.<br>Develop research skills especially in biological experiments, project writing and oral presentation. |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Define the basic principles of Blood grouping analysis<br>CO2: Describe the hemagglutination and precipitation<br>CO3: Illustrate the Vertical sectioning of plant stem, leaf and root.<br>CO4: Demonstrate the transverse sectioning of plant stem, leaf and root.<br>CO5: Examine the preparation of a permanent slide of plant tissue<br>CO6: Design the practical aspects of essential techniques important for biotechnological applications. |
| **7** | Course Description | Vocational education is concerned with the training on vocation. It is related to productivity. Vocational education prepares individuals for jobs. It has adequate employment potentialities. It helps in broadening of horizon. It leads to dignity of labor. It is helpful in the maximum utilization of the material resources of the country. |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Blood Analysis-1** | |
| | A | Studying the hemagglutination and precipitation | CO1, CO6 |
| | B | Blood grouping analysis; | CO1,CO6 |
| | C | Rh factor antigen analysis | CO1,CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | **Unit 2** | **Immunological Techniques** | | | |
| | A | Hematological analysis using light microscope | | | CO2, CO6 |
| | B | Quantitative estimation of antigen by radial immunodiffusion assay | | | CO2, CO6 |
| | C | Quantitative estimation of antigen by double immunodiffusion assay. | | | CO2, CO6 |
| | **Unit 3** | **Sectioning of Plant-1** | | | |
| | A | Vertical sectioning of plant stem | | | CO3, CO6 |
| | B | Vertical sectioning of plant leaf | | | CO3, CO6 |
| | C | Vertical sectioning of plant root | | | |
| | **Unit 4** | **Sectioning of Plant-2** | | | |
| | A | Transverse sectioning of plant stem | | | CO4, CO6 |
| | B | Transverse sectioning of plant Leaf | | | CO4, CO6 |
| | C | Transverse sectioning of plant root. | | | CO4, CO6 |
| | **Unit 5** | **Preparation of permanent plant tissue** | | | |
| | A | Preparation of a permanent slide of monocot plant | | | CO5, CO6 |
| | B | Preparation of a permanent slide of dicot plant | | | CO5, CO6 |
| | C | Study of flowering parts | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | Experiments in Microbiology, plant pathology and Biotechnology, K R Aneja | | | |
| | Reference books | | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | 3 | 2 | - | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO2** | 2 | 3 | 1 | - | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | - | 1 | 1 | 2 | 3 | 2 | 2 | 3 | 1 | 2 |
| **CO4** | 2 | 2 | 2 | - | 1 | 1 | 2 | 3 | 2 | 1 | 3 | 2 | 2 |
| **CO5** | 2 | 1 | 1 | - | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 2 |
| **CO6** | 2 | 3 | 2 | - | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 |
| **Avg** | 2.0 | 2.3 | 1.7 | - | 1.0 | 1.0 | 1.7 | 2.2 | 1.8 | 1.3 | 2.7 | 1.7 | 1.8 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI202** **Course Title: Basic Immunology Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** |
| **Branch: Biotechnology** | | **SEMESTER: III** |
| **1** | Course Code | **BBI202** |
| **2** | Course Title | **Basic Immunology Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | Compulsory |
| **5** | Course Objective | The objective of this course is to enable students to understand the fundamental principles of immunology and to develop an appreciation of the importance of synthesizing key concepts from a vast amount of experimental data that is rapidly emerging in this field. |
| **6** | Course Outcomes | After finishing the course, the students will be able to<br>CO1: Define basic laboratory techniques used in identification of blood groups<br>CO2: Describe the basic principle of hematological techniques<br>CO3: Illustrate the antigen antibody interactions<br>CO4: Examine the process of immunodiffusion and its applications<br>CO5: Appraise and evaluate different structures in primary and secondary lymphoid organs<br>CO6: Construct an understanding of basic immunological techniques, and hematological tests for their application in the field of health and diseases. |
| | **Course Description** | The course manages the physical, chemical and physiological characteristics of the components of the immune system. Immunology is the branch of biomedical science that deals with the study of an organism's immune system, in both health and diseases. |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Blood analysis** | |
| | A | To estimate the amount of Hb present in human blood | CO1, CO6 |
| | B | To find the blood group and Rh factor of blood | CO1,CO6 |
| | C | To perform blood smear formation | CO1,CO6 |
| | **Unit 2** | **Haematological Techniques** | |
| | A | Concept of Hemagglutination and Precipitation | CO2, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | B | Separation and counting of lymphocytes from blood | | | CO2, CO6 |
| | C | To perform Hemagglutination test | | | CO2, CO6 |
| | **Unit 3** | **ELISA** | | | |
| | A | Demonstration of ELISA | | | CO3, CO6 |
| | B | To perform Indirect ELISA | | | CO3, CO6 |
| | C | To perform Sandwich ELISA | | | |
| | **Unit 4** | **Immunodiffusion** | | | |
| | A | Principle and working of Immunodiffusion | | | CO4, CO6 |
| | B | To perform Ouchlerlony's double immunodiffusion method. | | | CO4, CO6 |
| | C | To perform Radial Immunodiffusion | | | CO4, CO6 |
| | **Unit 5** | **Study of permanent slides** | | | |
| | A | Study of Permanent slides of liver | | | CO5, CO6 |
| | B | Study of Permanent slides of spleen | | | CO5, CO6 |
| | C | study of permanent slide of bone marrow | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | Immunology: Overview and Laboratory Manual. Tobili Y. Sam-Yellow. Springer Cham 2021 | | | |
| | Reference books | | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 |
| **CO2** | **2** | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 |
| **CO3** | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 2 |
| **CO4** | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 2 | 1 | 2 |
| **CO5** | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 |
| **CO6** | 2 | 3 | 2 | **1** | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| **Avg** | 1.5 | 2.3 | 1.8 | 1.0 | 1.0 | 1.0 | 2.3 | 2.0 | 1.2 | 1.0 | 1.8 | 1.0 | 1.8 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

| | | | |
|---|---|---|---|
| **School:** SSBSR | | **Batch:** 2023-2027 | |
| **Programme:B.Sc.** | | **Academic Year:** 2024-2025 | |
| **Branch: Biotechnology** | | **Semester:** III | |
| 1 | Course Code | **ARP207** | Course Name: **Logical Skills Building and Soft Skills** |
| 2 | Course Title | **Logical Skills Building and Soft Skills** | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P) | 1-0-2 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To enhance holistic development of students and improve their employability skills. To provide a 360 degree exposure to learning elements of Business English readiness Programme, behavioural traits, achieve softer communication levels and a positive self-branding along with augmenting numerical and altitudinal abilities. To step up skill and upgrade students' across varied industry needs to enhance employability skills. By the end of this semester, a student will have entered the threshold of his/her 1st phase of employability enhancement and skill building activity exercise. | |
| 6 | Course Outcomes | After completion of this course, students will be able to:<br><br>CO1: Ascertain a compESEncy level through Building Essential Language and Life Skills<br><br>CO2: Build positive emotional compESEnce in self and learn GOAL Setting and SMART Goals techniques<br><br>CO3: Apply positive thinking, goal setting and success-focused attitudes, time Management, which would help them in their academic as well as professional career<br><br>CO4: Acquire satisfactory compESEncy in use of aptitude, logical and analytical reasoning<br><br>CO5: Develop strategic thinking and diverse mathematical concepts through building number puzzles<br><br>CO6: Demonstrate an ability to apply various quantitative aptitude tools for making business decisions | |
| 7 | Course Description | This Level 1 blended training approach equips the students for Industry employment readiness and combines elements of soft skills and numerical abilities to achieve this purpose. | |
| 8 | Outline syllabus – ARP 207 | | |

| | Unit 1 | BELLS ( Building Essential Language and Life Skills) | CO Mapping |
|---|---|---|---|
| | A | *Know Yourself*: Core CompESEnce. A very unique and interactive approach through an engaging questionnaire to ascertain a student's current skill level to design, architect and expose a student to the right syllabus as also to identify the correct TNI/TNA levels of the student. | CO1 |
| | B | Techniques of Self Awareness \| Self Esteem & Effectiveness\| Building Positive Attitude \| Building Emotional CompESEnce | CO1, CO2 |
| | C | Positive Thinking & Attitude Building \| Goal Setting and SMART Goals – Milestone Mapping \| Enhancing L S R W G and P (Listening Speaking Reading Writing Grammar and Pronunciation) \| | CO1, CO2,CO3 |
| | **Unit 2** | **Introduction to APTITUDE TRAINING- Reasoning- Logical/ Analytical** | |
| | A | Syllogism \| Letter Series \| Coding, Decoding , Ranking & Their Comparison Level-1 | CO4 |
| | B | Number Puzzles | CO5 |
| | C | Selection Based On Given Conditions | CO5 |
| | **Unit 3** | **Quantitative Aptitude** | |
| | A | Number Systems Level 1 \| Vedic Maths Level-1 | CO6 |
| | B | Percentage ,Ratio & Proportion \| Mensuration - Area & Volume \|Algebra | CO6 |
| | **Unit 4** | **Verbal Abilities – 1** | |
| | A | Reading Comprehension | CO1 |
| | B | Spotting the Errors | CO2 |
| | **Unit 5** | **Time & Priority Management** | |
| | A | Steven Covey Time Management Matrix | CO3 |
| | B | Creating Self Time Management Tracker | CO3 |
| | Weightage Distribution | *Class Assignment/Free Speech Exercises / JAM – 25% \| Group Presentations/Mock Interviews/GD/ Reasoning, Quant & Aptitude – 75%* | |
| | Text book/s* | *Wiley's Quantitative Aptitude-P Anand* \| ***Quantum CAT – Arihant Publications*** \| ***Quicker Maths- M. Tyra*** \| *Power of Positive Action (English, Paperback, Napoleon Hill) \| Streets of Attitude (English, Paperback, Cary Fagan, Elizabeth Wilson) The 6 Pillars of self-esteem and awareness – Nathaniel Brandon \| Goal Setting (English, Paperback, Wilson Dobson* | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | 1 | - | - | - | 1 | 3 | - | 2 | - |
| **CO2** | - | - | - | - | 1 | - | - | - | 1 | 3 | - | 2 | - |
| **CO3** | - | - | - | - | 1 | - | - | - | 1 | 3 | - | 2 | - |
| **CO4** | - | - | - | - | - | - | - | - | 1 | 2 | 1 | 2 | - |
| **CO5** | 1 | - | - | - | - | - | - | - | 1 | 2 | 1 | 2 | - |
| **CO6** | 1 | - | - | - | - | - | - | - | 1 | 2 | 1 | 2 | - |
| **Avg** | 1.0 | - | - | - | 1.0 | - | - | - | 1.0 | 2.5 | 1.0 | 2.0 | - |

**1. Slight (Low)** **2. Moderate (Medium)** **3. Substantial (High)**

# SEMESTER IV

**Course code: BBI212** **Course Title: Plant Diversity**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** | |
| **Branch: Biotechnology** | | **SEMESTER: IV** | |
| **1** | Course Code | **BBI212** | |
| **2** | Course Title | **Plant Diversity** | |
| **3** | Credits | **5** | |
| **4** | Contact Hours (L-T-P) | **5-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1. This course has been designed to make students understand the basic characteristics of microbes<br>2. To know about basis principle and to understand the methods of sterilization<br>3. Students understand the basic structure of Bacteria | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: define the morphology and diversity of Algae and its applications<br>CO2: classify the morphology and diversity of Fungi<br>CO3 apply the application of Fungi<br>CO4: compare morphology and classification of Bryophytes<br>CO5: assess plant diversity in nature<br>CO6: design the reproductive variability of Pteridophytes | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Diversity of Plants and Related Organisms** | CO1,CO6 |
| | A | The Five Kingdom of classification; Characteristics of Plants; Comparative Morphology of Algae: Unicellular Forms: *Chlamydomonas;* Colonial Forms*: Microcystis, Volvox*; Filamentous Forms: *Nostoc*; Thalloid Forms: *Fucus;* | |
| | B | Structure of Algal Cells; Reproduction and Life Cycle of *Chlamydomonas, Ulothrix,* Algal Habitats and Distribution; | |
| | C | Algae and Human Welfare: A Nutritional Food Source; Biofertilisers; Industrial Applications: Phycocolloids, Diatomite, Pigments; Medicinal Uses; Harmful Effects | |
| | **Unit 2** | **Fungi** | CO2, CO6 |
| | A | Fungal Habitats, Nutrition and Growth, Unicellular Forms -Yeast, Slime Moulds, Filamentous Forms, The Fine Structure of Fungi | |
| | B | Vegetative, Asexual, Sexual; Types of Life Cycles and Alternation of Generations *Rhizopus, Neurospora*. | |
| | C | Fungal Diseases: Symptoms, Pathogen, Disease Cycle and Control Measures of Late Blight of Potato: (*Phytophthora infestans*), Red Rot of Sugarcane (*Colletotrichum falcatum*), Wheat Rusts (*Puccinia graminis*), | |

| | | | |
|---|---|---|---|
| | **Unit 3** | **Fungi Application** | CO3, CO6 |
| | A | Skin Diseases: Facial Eczema, Sporotrichosis and Ring Worm. | |
| | B | Role of Fungi in Human Welfare: Food Provider; Food Spoiler; Fermentation; Antibiotics; Mycorrhizal Fungi; | |
| | C | Introduction to Lichens: A Model of Symbiotic System; Importance of Lichens in Ecology, as Food, Indicators of Pollution etc. | |
| | **Unit 4** | **Bryophytes** | CO4, CO6 |
| | A | Morphology and Anatomy of Bryophytes: General Characteristics and Life Cycle; Adaptations to Land Habit; Morphology and Anatomy of *Riccia, Marchantia, Anthoceros; Funaria.* | |
| | B | General Features of Sexual Reproduction in Bryophytes: *Riccia, Marchantia, Anthoceros, Funaria* | |
| | C | Importance and Uses of Bryophytes: Medicine,, Decorative and Packing Materials, House Hold Uses, Treatment of Waste Water, Mosses as Animal Food and Shelter; Horticulture; Ecological Role in Soil Erosion, Indicators of Mineral Deposits; Bryophytes as Preserver of the Past; | |
| | **Unit 5** | **Pteridophytes** | CO5, CO6 |
| | A | Comparative Morphology and Anatomy, Pteridophytic Life Cycle; Morphology and Anatomy of *Lycopodium, Selaginella ,Equisetum, Marsilea;* | |
| | B | Comparative Study of Reproduction in Pteridophytes:, Lycopodium, Selaginella, Equisetum and Marsilea; Vegetative Reproduction | |
| | C | Lower Plants; Telome Concept; Stelar Structure and Evolution; HESErospory and Seed Habit; Fern as a System for Experimental Studies: Polarity, Regeneration, Apogamy and Apospory. | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Textbook of Botany. Singh, Pande, Jain. Rastogi Publications | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | 1 | 1 | - | 3 | 1 | - | 2 | 1 | 1 | - | 1 |
| **CO2** | 2 | 1 | 1 | 1 | - | 3 | 1 | - | 2 | 1 | 1 | - | 1 |
| **CO3** | 3 | 1 | 1 | 1 | - | 3 | 1 | - | 2 | 1 | 2 | - | 2 |
| **CO4** | 2 | 1 | - | 1 | - | 2 | 1 | - | 2 | 1 | 1 | - | 1 |
| **CO5** | 3 | - | - | 1 | - | 1 | 2 | - | 2 | 1 | 2 | - | 2 |
| **CO6** | 2 | - | 1 | 1 | - | 2 | 2 | - | 2 | 1 | 1 | - | 1 |
| **Avg** | 2.5 | 1.0 | 1.0 | 1.0 | - | 2.3 | 1.3 | - | 2.0 | 1.0 | 1.3 | - | 1.3 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI213** **Course Title: Introduction to Genetic Engineering**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** | |
| **Branch: Biotechnology** | | **SEMESTER: IV** | |
| **1** | Course Code | **BBI213** | |
| **2** | Course Title | **Introduction to Genetic Engineering** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | DSE | |
| **5** | Course Objective | This course contains various metabolic pathways inside living cells such as metabolism of carbohydrates, lipids, nucleic acids and also carbon dioxide fixation. After studying course, students will be able to learn various metabolic processes going inside the body of living cells. | |
| **6** | Course Outcomes | The student at the completion of the course will be able to:<br>CO1: Define various molecular tools for genetic engineering; host cells and right kind of enzymes to perform DNA digestion, ligation etc.<br>CO2: Illustrate different kinds of cloning vectors and their uses.<br>CO3: Identify the use of Polymerase chain reaction in molecular cloning along and describe various DNA sequencing techniques.<br>CO4: Examine different ways of cloning blunt ended DNA fragments and transfection as well as transformation methods.<br>CO5: Assess different types of gene libraries and apply different techniques of probing gene libraries.<br>CO6: Elaborate the concept of genetic engineering to imply in field of research. | |
| | Course Description | Genetic engineering, also called genetic modification or genetic manipulation, is the modification and manipulation of an organism's genes using technology. It is a set of technologies used to change the genetic makeup of cells, including the transfer of genes within and across species boundaries to produce improved or novel organisms | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Molecular tools of genetic engineering** | CO1,CO6 |
| | A | Restriction enzymes Type I, II and III | |
| | B | DNA polymerase and RNA polymerase' reverse Transcriptase | |
| | C | Modifying enzymes terminal deoxynucleotidyl transferase, polynucleotide kinase, Phosphatases and DNA ligase; Screening methods; Blotting techniques (Southern, Northern and Western blotting) | |
| | **Unit 2** | **Cloning Vectors** | CO2, CO6 |
| | A | Introduction to cloning vectors; Phage vectors; cosmid vectors; phagemid vectors; Plasmid vectors BAC vectors and YAC vectors | |

| | | | |
|---|---|---|---|
| | B | Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosome walking, Screening of DNA libraries using nucleic acid probes and antisera.; | |
| | C | Cloning of insulin gene and other genes of commercial interest, strain improvement of industrially important organisms. | |
| | **Unit 3** | **Types of PCR and application** | CO3, CO6 |
| | A | PCR introduction and types of PCR: Inverse PCR, Nested PCR, AFLP-PCR. | |
| | B | Asymmetric PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay | |
| | C | Applications of PCR; Site directed mutagenesis.; molecular markers (RAPD, RFLP, AFLP, SNP) | |
| | **Unit 4** | **Cloning techniques and Recombinant products** | CO4, CO6 |
| | A | Steps to cloning; PCR- DNA amplification; Cloning after restriction digestion, blunt and cohesive end ligation; creation of restriction sites by PCR | |
| | B | cloning using linkers and adapters; cloning after homopolymer tailing; Strategies for cloning PCR products – TA cloning, Recombinant products | |
| | C | Recombinant products – human growth hormone (insulin, somatotropin), Vaccines (hepatitis B virus vaccine, FMD vaccine) | |
| | **Unit 5** | **Applications of genetic engineering** | CO5, CO6 |
| | A | Creation of recombinant microorganisms, cloning of sheep (Dolly) & other mammals; | |
| | B | Therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning; | |
| | C | Techniques of Genetic Engineering : Gene therapy; DNA drugs and vaccines. | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Molecular Biotechnology. Principles and Applications. 3rd Edition. Glick BR and Pasternak JJ. ASM Press 2003. ISBN 1-55581-224-4. | |
| | Other References | Gene cloning and DNA Analysis- An Introduction. 6th Edition. Wiley-Blackwell. Brown TA, 2010 | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 1 | - | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 1 | - | 3 | 1 | - | 3 | 1 | 3 | 2 | 2 |
| **CO3** | 2 | 3 | 3 | 1 | - | - | 1 | - | 3 | 1 | 3 | 3 | 3 |
| **CO4** | 2 | 3 | 3 | 1 | - | 3 | 1 | - | 2 | 1 | 3 | 1 | 1 |
| **CO5** | 2 | 3 | 3 | 3 | 1 | - | - | 3 | 2 | 1 | 3 | 1 | 2 |
| **CO6** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| **Avg** | 2.8 | 3.0 | 3.0 | 1.3 | 2.0 | 2.5 | 1.4 | 2.3 | 2.2 | 1.3 | 3.0 | 1.8 | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BSB206** **Course Title: Enzyme Technology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** | |
| **Branch: Biotechnology** | | **SEMESTER: IV** | |
| **1** | Course Code | BSB206 | |
| **2** | Course Title | Enzyme Technology | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1.Introduction to Enzymes, their classification and nomenclature<br>2.Factors affecting enzymatic catalysis<br>3. Enzyme substrate kinetics<br>4.Isolation, purification and Immobilization of Enzymes<br>5. Applications of enzymes in various industries | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Show an overview on enzymes, their nomenclature and factors affecting enzyme activity<br>CO2: Classify the factors affecting rate of biochemical reactions, lock and key as well as induced fit hypothesis<br>CO3: Build the kinetics of enzyme catalysis as well as inhibition reactions<br>CO4: Analyze the isolation, purification and immobilization of enzymes<br>CO5: Conclude the Industrial and clinical application of enzymes<br>CO6: Adapt the use of enzymes in leather, dairy, pharmaceutical, food processing and various other industries for human welfare | |
| **7** | Course Description: | The course comprises of the study of enzymes, their nomenclature, classification etc. It comprises of the Fischer's Lock and key as well as Koshland's Induced fit theory of enzyme substrate reaction, enzyme kinetics and applications of enzymes in various industrial sectors | |
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Enzymes as Catalysts: Overview** | CO1,CO6 |
| | A | Proteins as catalysts (Historical background); Enzyme nomenclature & classification; EC number of enzymes | |
| | B | Enzyme characteristics and properties; Factors affecting Enzyme Activity | |
| | C | Co-enzyme; Co-factors and their role in enzyme activity; Structure and function of coenzymes - TPP, pyrodoxal phosphate, Nicotinamide, flavin nucleotide, coenzyme A and biotin | |
| | **Unit 2** | **Factors affecting the rate of chemical reactions** | CO2, CO6 |

| | | | |
|---|---|---|---|
| | A | Collision theory, activation energy and transition state theory | |
| | B | Catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site) | |
| | C | Fischer's lock and key hypothesis, Koshland's induced fit hypothesis | |
| | **Unit 3** | **Enzyme Kinetics** | CO3, CO6 |
| | A | Kinetics of single substrate reactions, | |
| | B | Enzyme inhibition Irreversible and reversible inhibition | |
| | C | Competitive non-competitive and un-competitive inhibition | |
| | **Unit 4** | **Isolation, purification and immobilization of enzymes** | CO4, CO6 |
| | A | Isolation and purification of enzymes | |
| | B | Localization of proteins in various organelles/Enzyme Immobilization: Adsorption, Matrix entrapment, Encapsulation, Cross linking, covalent binding and their examples. Enzyme stabilization & protein engineering; Catalytic antibodies | |
| | C | Advantages and disadvantages of different immobilization techniques | |
| | **Unit 5** | Industrial and Clinical Applications of Enzymes | CO5, CO6 |
| | A | Applications in leather industry, food processing industry | |
| | B | Applications in dairy industry, pharmaceutical industry | |
| | C | Enzyme engineering: In vitro approaches to improve functional efficiency; Recombinant enzymes and their uses | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Text Book: Palmer T., Bonner P. L., Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, Woodhead Publishing (2007) | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 1 | - | 1 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 1 | 1 | - | - | 1 | 2 | 3 | 3 | 2 | 3 | 1 | 3 |
| **CO3** | 3 | 1 | 2 | - | - | 1 | 3 | 3 | 3 | 2 | 3 | 1 | 2 |
| **CO4** | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 |
| **CO5** | 2 | 1 | 2 | - | - | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 2 |
| **CO6** | 3 | 2 | 3 | - | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 1 | 2 |
| **Avg** | 2.7 | 1.3 | 1.7 | 1.0 | 1.3 | 1.8 | 2.3 | 3.0 | 2.3 | 2.3 | 2.8 | 1.7 | 2.5 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI214** **Course Title: Introduction to Human Physiology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** | |
| **Branch: Biotechnology** | | **SEMESTER: IV** | |
| **1** | Course Code | **BBI214** | |
| **2** | Course Title | **Introduction to Human Physiology** | |
| **3** | Credits | **5** | |
| **4** | Contact Hours (L-T-P) | **5-0-0** | |
| | Course Status | Minor | |
| **5** | Course Objective | To understand the functioning of major human system including digestive, respiration, kidney, reproductive system etc | |
| **6** | Course Outcomes | The student at the completion of the course will be able to:<br>CO1: Understand the digestion and absorption of the body.<br>CO2: Describe the structure and functions of nerve and muscles<br>CO3: Illustrate the concept of physiology of respiration<br>CO4: Compare different ways of the Renal Physiology and Cardiovascular Physiology.<br>CO5: Assess the functioning of Endocrine and Reproductive system<br>CO6: Elaborate the concept of the basic functioning of human physiology. | |
| | Course Description | This course comprises of the structure, function of major systems to understand the holistic view of human functioning. Several different systems viz. respiratory, digestive, kidney, cardiovascular, reproductive, endocrine system will be studied for basic understanding. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Digestion and Absorption of Food** | CO1,CO6 |
| | A | Structure and function of digestive glands | |
| | B | Digestion and absorption of carbohydrates, fats and proteins | |
| | C | Nervous and hormonal control of digestion (in brief) | |
| | **Unit 2** | **Functioning of Excitable Tissue (Nerve and Muscle)** | CO2, CO6 |
| | A | Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); | |
| | B | Structure of skeletal muscle | |
| | C | Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction | |
| | **Unit 3** | **Respiratory Physiology** | CO3, CO6 |
| | A | Ventilation, External and internal Respiration | |
| | B | Transport of oxygen and carbon dioxide in blood | |
| | C | Factors affecting transport of gases | |

| | | | |
|---|---|---|---|
| | **Unit 4** | **Renal Physiology and Cardiovascular Physiology** | CO4, CO6 |
| | A | Functional and anatomy of kidney, | |
| | B | Mechanism and regulation of urine formation | |
| | C | Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG | |
| | **Unit 5** | **Endocrine and Reproductive Physiology** | CO5, CO6 |
| | A | Structure and function of endocrine glands | |
| | B | Pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes, | |
| | C | Brief account of spermatogenesis and oogenesis, Menstrual cycle | |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Molecular Biotechnology. Principles and Applications. 3rd Edition. Glick BR and Pasternak JJ. ASM Press @2003. ISBN 1-55581-224-4. | |
| | Other References | Gene cloning and DNA Analysis- An Introduction. 6th Edition. Wiley-Blackwell. Brown TA, 2010 | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | - | - | - | - | 1 | - | 2 | - | 1 | - | 1 |
| **CO2** | 2 | 1 | - | - | - | - | 1 | - | 1 | - | 1 | - | 1 |
| **CO3** | 2 | 1 | - | - | - | - | 1 | - | 2 | - | 1 | - | 2 |
| **CO4** | 2 | 1 | - | - | - | - | 1 | - | 2 | - | 1 | - | 2 |
| **CO5** | 2 | 1 | - | - | - | - | 1 | - | 2 | - | 1 | - | 1 |
| **CO6** | 2 | 1 | - | - | - | - | 1 | - | 2 | - | 1 | - | 1 |
| **Avg** | 2.0 | 1.0 | - | - | - | - | 1.0 | - | 1.8 | - | 1.0 | - | 1.3 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course Code: CHE 113** **Course Title: Chemistry IV**

| | | | |
|---|---|---|---|
| 1 | Course No. | CHE 113 | |
| 2 | Course Title | Chemistry IV | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| 5 | Course Objective | • To provide the basics of Chemical equilibrium, ionic equilibrium, thermochemistry and chemical kinetics so as to apply on various biological systems.<br>• To make students confident in making solutions of concentrations and standardize them. | |
| 6 | Course Outcomes | Students will be able to:<br>CO1: Understand basics of Chemical equilibrium.<br>CO2: Identify the components of a buffer and their function and realize the different types of salts solution and their pH<br>CO3: explain the concept of enthalpy change in different reactions and Heat capacities.<br>CO4: recognize the order of reactions and role and working of catalyst<br>CO5: prepare solutions with desired molar or percent concentrations and carry out dilutions of these solutions and different types of titrations and understand the choice of indicators<br>CO6: apply the basic knowledge to solve various analytical problems. | |
| **7** | **Outline Syllabus** | Minor | |
| | **Unit 1** | **Chemical Equilibrium** | |
| | A | Law of mass action; Thermodynamic treatment of Law of mass action, Relation between Kp, Kc and Kx | CO1 |
| | B | Variation of equilibrium constant with temperature - The Van't Hoff Equation; | CO1 |
| | C | Le-chatelier's principle and its application. | CO1, CO6 |
| | **Unit 2** | **Ionic Equilibrium** | |
| | A | Strong and Weak acids and bases, ionization constants of weak acids and bases, pH and pOH, Ionic product of water | CO2 |
| | B | Common Ion Effect, Buffers and their types, pH of buffers-Henderson equation for acidic and basic buffers. | CO2, CO6 |
| | C | Solubility products, Salt Hydrolysis and pH of salt solutions | CO2 |
| | **Unit 3** | **Thermochemistry** | |
| | A | Principles of heat flow, enthalpy, calorimetry, Heat capacity ($C_v$ and $C_p$) and specific heats | CO3, CO6 |
| | B | Hess's Law, heats of formation, Different types of Heat of a reaction | CO3, CO6 |
| | C | Effect of temperature on heat of reaction, at constant pressure (Kirchoff's Equation). | CO3, CO6 |
| | **Unit 4** | **Chemical Kinetics** | |
| | A | Rates of reactions and its expressions, Reactions of Zero, First and second order, half lives | CO4, CO6 |
| | B | Determination of order of reactions by half life method, Activation energy, Effect of temperature on rate of reaction | CO4, CO6 |
| | C | Types and characteristics of catalysis, Elementary enzyme | CO4, CO6 |

| | | | |
|---|---|---|---|
| | | catalyzed reactions | |
| | **Unit 5** | **Titrations** | |
| | A | General principle. Requirements for titrimetric analysis and Concentration systems | CO5, CO6 |
| | B | Primary and secondary standards, criteria for primary standards, Types of titrations, Limitation of volumetric analysis | CO5, CO6 |
| | C | endpoint and equivalence point, Theoretical aspects of acid-base titration curves and end point evaluation, Choice of indicators | CO5, CO6 |
| **8** | **References** | | |
| 8.1 | Text Book | 1. Essentials of Physical Chemistry by B.S. Bahl and G.D. Tuli.<br>2. Concise Inorganic Chemistry by J. D. Lee 5th Edition.<br>3. Stereochemistry Conformation and Mechanism By P S Kalsi<br>4. College Chemistry by Linus Pauling | |
| 8.2 | Other references | 1. Text Book of Physical Chemistry by Samuel Glasstone<br>2. Physical Chemistry by Walter J Moore<br>3. Physical Chemistry by Atkin<br>4. Arthur I. Vogel's Quantitative Inorganic Analysis including Elementary Instrumental Analysis, ELBS, Longmann Group, 5th Edition, 1989. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 1 | - | - | - | 2 | 1 | 1 | 1 | 2 | - | - |
| **CO2** | 2 | 2 | 1 | - | - | - | 2 | 1 | 1 | 1 | 3 | - | - |
| **CO3** | 2 | 1 | 1 | - | - | - | 1 | 1 | 1 | 1 | 2 | - | - |
| **CO4** | 2 | 2 | 1 | - | - | - | 2 | 1 | 1 | 1 | 2 | - | - |
| **CO5** | 2 | 2 | 2 | - | - | - | 2 | 1 | 1 | 1 | 3 | - | - |
| **CO6** | 2 | 3 | 2 | - | - | - | 2 | 1 | 1 | 1 | 3 | - | - |
| **Avg** | 2.0 | 1.8 | 1.3 | - | - | - | 1.8 | 1.0 | 1.0 | 1.0 | 2.5 | - | - |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BSP205** **Course Title: Genetic Engineering Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** |
| **Branch: Biotechnology** | | **SEMESTER: IV** |
| **1** | Course Code | **BSP205** |
| **2** | Course Title | **Genetic Engineering Lab** |
| **3** | Credits | **2** |
| **4** | Contact Hours (L-T-P) | **0-0-4** |
| | Course Status | DSE |
| **5** | Course Objective | To learn the different techniques used for genetic engineering |
| **6** | Course Outcomes | After completion of this course, students will be able to:<br>CO1: List the experiments on DNA isolation from biological resources<br>CO2: Illustrate the particular gene of interest by PCR method.<br>CO3: Build the amplified gene by electrophoresis method<br>CO4: Categorize the gene of interest in the expression vector<br>CO5: Choose the gene of interest<br>CO6: Construct the use different tools of genetic engineering |
| | Course description | Genetic engineering will help to develop novel genes of economic importance that can be used to improve the genetics of microorganisms |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **DNA** | |
| | A | Principle of DNA isolation | CO1, CO6 |
| | B | Buffer preparation of DNA Isolation | CO1,CO6 |
| | C | DNA isolation from bacteria | CO1,CO6 |
| | **Unit 2** | **PCR** | |
| | A | Concept and working of PCR | CO2, CO6 |
| | B | Demonstration of PCR machine | CO2, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | C | Amplification of specific gene of interest by PCR method | | | CO2, CO6 |
| | **Unit 3** | Validation of amplified gene | | | |
| | A | Preparation of buffers | | | CO3, CO6 |
| | B | Concept and working of Electrophoresis | | | CO3, CO6 |
| | C | Validation of amplified gene by electrophoresis method | | | |
| | **Unit 4** | **Cloning of gene** | | | |
| | A | Concept of gene cloning and expression vector | | | CO4, CO6 |
| | B | Preparation of buffers | | | CO4, CO6 |
| | C | Cloning of gene of interest in expression vector | | | CO4, CO6 |
| | **Unit 5** | **Protein expression** | | | |
| | A | Concept of protein expression | | | CO5, CO6 |
| | B | Growth of Cloned bacteria in media plate and broth | | | CO5, CO6 |
| | C | To check the protein expression of the vector | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | Brown T.A, "Gene Cloning and DNA Analysis: An Introduction", John Wiley & Sons, 2010. | | | |
| | Reference books | Old R.W and Primrose S.B., "Principles of Gene Manipulation", Blackwell Scientific Publication, 2002. | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 3 | 3 | 1 | 1 | 1 | 3 | 3 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 3 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 1 | 2 |
| **CO4** | 3 | 3 | 3 | 1 | 1 | 3 | 1 | 1 | 1 | 3 | 2 | 1 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 3 | 3 | 1 | 2 |
| **CO6** | 3 | 3 | 3 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 1 | 2 |
| **Avg** | 3.0 | 3.0 | 3.0 | 1.3 | 1.5 | 2.0 | 1.3 | 1.3 | 1.3 | 3.0 | 2.8 | 1.0 | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: RBL002** **Course Title: Research Based Learning II**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2024-25** |
| **Branch: Biotechnology** | | **SEMESTER: IV** |
| **1** | Course Code | RBL002 |
| **2** | Course Title | **Research Based Learning II** |
| **3** | Credits | **Audit Based** |
| **4** | Contact Hours (L-T-P) | **0-0-4** |
| | Course Status | Compulsory |
| **5** | Course Objective | Develop knowledge of a specific area of specialization.<br>Develop research skills especially in biological experiments, project writing and oral presentation. |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>**CO1:** Articulate research-based investigation done on a topic<br>**CO2:** Demonstrate capacity to identify theoretical/experimental method followed in the research articles<br>**CO3:** Demonstrate an understanding of the ethical issuesassociated with practitioner research<br>**CO4:** Compare research data and extract the outstandingresults<br>**CO5:** Report research findings in written and verbal forms<br>**CO6:** Use research findings to advance education theory andpractice |
| | Course Description | Research-based learning (RBL) aims to promote and develop student compESEncies related to research practice and to benefit students through activities linked to research [. This technique implies the application of learning and teaching strategies that link research with teaching |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Introduction to various research problems** | **CO1,CO6** |
| | **Unit 2** | **Identify a research question** | **CO2,CO6** |
| | **Unit 3** | **Literature survey** | **CO3,CO6** |
| | **Unit 4** | **Report writing** | **CO4,CO6** |
| | **Unit 5** | **Presentation** | **CO5 ,CO6** |

| | | | | | |
|---|---|---|---|---|---|
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | 10 Recent International Journal Articles of repute. | | | |
| | Reference books | | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO3 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| CO5 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 2 |
| CO6 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 |
| Avg | 1.5 | 2.0 | 1.5 | 1.8 | 1.2 | 1.0 | 1.7 | 1.8 | 1.8 | 1.2 | 2.3 | 1.7 | 1.7 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

# SEMESTER V

**Course code: BBI303** **Course Title: Animal Diversity**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-26** | |
| **Branch: Biotechnology** | | **SEMESTER: V** | |
| **1** | Course Code | **BBI303** | |
| **2** | Course Title | **Animal Diversity** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1. This course has been designed to make students understand the animal kingdom diversity<br>2. To know the morphology and life cycle of invertebrates | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Define and understand the organization and classification of animal kingdom<br>CO2: classify the morphology and diversity of Protozoans<br>CO3 Illustrate the general characteristics of Cnidaria and Acnidaria<br>CO4: To analyze Helminthes<br>CO5: To assess Annelids<br>CO6: To discuss the invertebrate diversity of animal kingdom | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Organisation and classification of Animal Kingdom** | CO1,CO6 |
| | A | Organisation: Classification Systems – Two Kingdom Classification, Five Kingdom Classification and Limitations | |
| | B | Levels of Body Organisation; Characteristics of Metazoa; Symmetry – Asymmetrical and Spherical, Radial and Biradial, Bilateral; Development Patterns – Cleavage, Fate of Blastopore; | |
| | C | Germ Layers; Body Cavity Pseudocoelom, Coelom; Cephalisation and Segmentation; Origin and Evolution of Metazoa | |
| | **Unit 2** | **Protozoans** | CO2, CO6 |
| | A | General Characteristics, Structural Organisation and Function – Body form, Locomotor Organelles, Nutrition Osmoregulation and Excretion, Respiration, Mechanisms for Response,Encystment; | |
| | B | Classification of Protozoa ; Parasitic Protozoans- Amoebae, Flagellates | |
| | C | Type study: Entamoeba histolytica or malaria– External morphology, lifecycle. | |
| | **Unit 3** | **Cnidaria and Acnidaria** | CO3, CO6 |

| | | | |
|---|---|---|---|
| | A | Cnidaria: General characters and classification of Phylum Cnidaria up to classes with examples,<br>Type study: Obelia | |
| | B | Corals and coral reefs, their types, formation, theories and importance. | |
| | C | Acnidaria (Ctenophora): General characters with examples | |
| | **Unit 4** | **Helminthes – Platyhelminthes and Nemathelminthes** | CO4, CO6 |
| | A | Platyhelminthes: General characters and classification of Phylum Platyhelminthes up to classes with examples | |
| | B | Nemathelminthes: General characters and classification of Phylum Nemathelminthes. | |
| | C | Type study: Ascaris – External morphology, digestive system, excretory system, reproductive system and life-cycle. | |
| | **Unit 5** | **Annelida** | CO5, CO6 |
| | A | General characters and classification of Phylum Annelida up to classes with examples, | |
| | B | Type study: Nereis – External morphology, coelom, locomotion, digestive system, | |
| | C | Blood vascular system, excretory system, reproductive system, life-history and regeneration. | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Modern Textbook of Zoology Invertebrates by R.L. Kotpal – (Rastogi Publications, Meerut, 10th Revised Edition). | |
| | Other References | 1. Invertebrate Zoology by E.L.Jordon and P.S. Verma – S. Chand & Co., Delhi).<br>2. 4. Invertebrate Zoology by J.K. Dhami and P.S. Dhami – S. Chand & Co., Delhi).<br>3. 5. A Textbook of Invertebrate Zoology by S.N. Prasad – (Kitab Mahal, Allahabad).<br>4. 6. Life of Invertebrates by Russel and Hunter – (Macmillan) | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | - | - | - | 1 | 2 | 3 | - | 2 | 2 | 2 | 1 | 2 |
| **CO2** | 1 | - | - | - | 1 | 1 | 2 | - | 1 | 1 | 1 | 1 | 1 |
| **CO3** | 1 | - | - | - | 1 | 1 | 2 | - | 1 | 1 | 1 | 1 | 1 |
| **CO4** | 1 | - | - | - | 1 | 2 | 2 | - | 1 | 1 | 1 | 1 | 1 |
| **CO5** | 1 | - | - | - | 1 | 1 | 2 | - | 1 | 1 | 1 | 1 | 1 |
| **CO6** | 2 | - | - | - | 1 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | 2 |
| **Avg** | 1.2 | - | - | - | 1.0 | 1.7 | 2.3 | 1.0 | 1.3 | 1.3 | 1.3 | 1.0 | 1.3 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-26** | |
| **Branch: Biotechnology** | | **SEMESTER: V** | |
| **1** | Course Code | **BBI303** | |
| **2** | Course Title | Fundamentals of Bioprocess Technology | |
| **3** | Credits | **5** | |
| **4** | Contact Hours (L-T-P) | **5-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | • Understand the basics of bioreactor engineering with knowledge on design and operation of fermentation processes.<br>• Develop bioengineering skills for the production and purification of biochemical product using integrated biochemical processes | |
| **6** | Course Outcomes | **Course outcomes**<br>After studying this course, students will be able to<br>**CO1:** Define basics of fermentation.<br>**CO2:** Explain the mode of operation of the bioreactors.<br>**CO3:** Identify Control in Fermenter and transport phenomenon.<br>**CO4:** Analyze the Downstream Processing.<br>**CO5:** Evaluate the quality of the fermentation Product<br>**CO6:** Elaborate the whole process of bioprocess technology | |
| **7** | Course Description | To learn the fundamentals and techniques to obtain biological products with the help of fermentation technology. It encompasses the design, operation, control, and optimization of biochemical processes involving various biological pathways | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Basics of fermentation** | CO1,CO6 |
| | A | Basic principle in bioprocess technology. Upstream: Media formulation, Inoculum development and aseptic transfers. | |
| | B | History of fermentation, submerged and solid state fermentation, Nutrient requirements for microbial growth, | |
| | C | Growth kinetics of microbes. Sterilization of media and equipments for fermentation | |
| | **Unit 2** | **Different mode of bioreactor operation** | CO2, CO6 |
| | A | Batch, Continuous and Fed batch mode of operation. | |
| | B | Operational design of Bioreactor- vessel, agitator, sparger, baffles, types of Bioreactors- STR, CSTR | |
| | C | Airlift fermenter, Fluidized bed reactor, Packed bed reactor, Immobilized cells and enzymes bioreactor | |
| | **Unit 3** | **Control in Fermentor and transport phenomena** | CO3, CO6 |

| | | | |
|---|---|---|---|
| | A | Measurement, monitoring and control of physical, chemical and biological parameters in a bioreactor. | |
| | B | Transport phenomena in bioreactor, Aeration and agitation in bioreactors. | |
| | C | pH and temperature control in bioreactor. | |
| | **Unit 4** | **Downstream Processing-1** | CO4, CO6 |
| | A | Solids (Insolubles) Removal: Filtration; | |
| | B | Centrifugation; Coagulation and flocculation; | |
| | C | Foam fractionation; | |
| | **Unit 5** | **Downstream Processing-2** | CO5, CO6 |
| | A | Whole-broth treatment; | |
| | B | Primary Product Isolation: Cell disruption | |
| | C | Liquid extraction; Dissociation extraction; Ion-exchange adsorption; precipitation; | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Principles of fermentation technology, Stanbury P.F. et al, Butterworth- Heinemann Ltd, | |
| | Other References | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | 2 | 1 | 1 | 1 | - | 2 | 3 | - | 2 |
| **CO2** | 3 | 3 | 2 | - | 2 | - | 1 | 1 | 2 | 1 | 3 | - | 2 |
| **CO3** | 3 | 2 | 3 | - | 2 | 1 | 1 | 1 | 1 | 1 | 3 | - | 1 |
| **CO4** | 3 | 2 | 2 | - | 2 | 1 | 1 | 1 | - | 1 | 3 | - | 1 |
| **CO5** | 3 | 3 | 2 | - | 2 | - | 1 | 2 | 1 | 2 | 3 | - | 2 |
| **CO6** | 2 | 3 | 3 | - | 3 | - | 1 | 2 | 2 | 2 | 3 | - | 2 |
| **Avg** | 2.8 | 2.5 | 2.3 | - | 2.2 | 1.0 | 1.0 | 1.3 | 1.5 | 1.5 | 3.0 | - | 1.7 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI304** **Course Title: Biochemistry of Metabolic Pathways**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-26** | |
| **Branch: Biotechnology** | | **SEMESTER: V** | |
| **1** | Course Code | **BBI304** | |
| **2** | Course Title | **Biochemistry of Metabolic Pathways** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | **DSE** | |
| **5** | Course Objective | It is to learn the different metabolic pathways:<br>1.Carbohydrate Metabolism<br>2. Lipid metabolism<br>3. Amino Acid Metabolism<br>4. Electron Transport Chain<br>5. Nucleotide Metabolism | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Relate metabolism of carbohydrates by different pathways<br>CO2: Compare the metabolism of different types of lipids<br>CO3: Identify between gluconeogenic and ketogenic amino acids<br>CO4: Analyze the process of electron transport chain<br>CO5: Evaluate de novo and salvage pathways for biosynthesis of purines and Pyrimidines<br>CO6: To develop a comprehensive understanding of several pathways involved in the metabolism | |
| | Course Description | This course contains various metabolic pathways inside living cells such as metabolism of carbohydrates, lipids, nucleic acids and also carbon dioxide fixation. After studying course, students will be able to learn various metabolic processes going inside the body of living cells. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Glucose Metabolism and Regulation of Metabolism** | CO1,CO6 |
| | A | Glycolysis, Glycogenosis, Krebs's cycle and net energy yield | |
| | B | Pentose Phosphate pathway (PPP) at molecular, cellular Level | |
| | C | Study of Important Enzymes in glycolysis, Kreb cycle and PPP and receptors as drug targets | |
| | **Unit 2** | **Fat Metabolism** | CO2, CO6 |
| | A | Beta oxidation of fatty acids and energy yield | |
| | B | Cholesterol synthesis | |
| | C | Synthesis of fatty acids | |
| | **Unit 3** | **Amino Acid metabolism and disorder** | CO3, CO6 |

| | | | |
|---|---|---|---|
| | A | Introduction to gluconeogenic and ketogenic amino acids; | |
| | B | Degradation of amino acids; Urea Cycle | |
| | C | Synthesis of amino acids | |
| | **Unit 4** | **Electron transport Chain** | CO4, CO6 |
| | A | ATP synthase and proton transfer during electron transfer | |
| | B | Coupling of electron transport to oxidative phosphorylation | |
| | C | Inhibitors of electron transport | |
| | **Unit 5** | **Nucleotide Metabolism and introduction to enzyme** | CO5, CO6 |
| | A | Biosynthesis of purines Biosynthesis of pyrimidines | |
| | B | Nature of enzymes – kinetics, reaction mechanism of chymotrypsin and lysozyme purification and physico – chemical characterization, | |
| | C | regulation of enzyme activity | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Stryer L., "Biochemistry", W. H. Freeman, 2010. | |
| | Other References | Jain JL., "Principles of Biochemistry", S. Chand Publications. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | - | 1 | - | 2 | - | 3 | 1 | 2 | 2 | 1 | 3 | 2 |
| **CO2** | 2 | - | 1 | - | 2 | - | 3 | 1 | 1 | 1 | 1 | 3 | 2 |
| **CO3** | 2 | - | 1 | - | 2 | - | 3 | 1 | 1 | 1 | 1 | 3 | 2 |
| **CO4** | 2 | - | - | - | 2 | - | 2 | 1 | 2 | 1 | 1 | 3 | 2 |
| **CO5** | 2 | - | - | - | 2 | - | 2 | 1 | 1 | 1 | 1 | 3 | 2 |
| **CO6** | 2 | - | 1 | - | 2 | - | 3 | 1 | 3 | 3 | 1 | 3 | 2 |
| **Avg** | 2.0 | - | 1.0 | - | 2.0 | - | 2.7 | 1.0 | 1.7 | 1.5 | 1.0 | 3.0 | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI302** **Course Title : Plant Anatomy & Physiology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year:** | |
| **Branch: Biotechnology** | | **SEMESTER: V** | |
| **1** | Course Code | **BBI302** | |
| **2** | Course Title | **Plant Anatomy & Physiology** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | This course aims to educate student about the<br>1. Plant anatomy<br>2. mechanism and physiology life processes in plants.<br>3. It focusses on the plant nutrient uptake and translocation, photosynthesis, respiration and nitrogen metabolism. and are able to coordinate the various processes | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Define the anatomy of plant<br>CO2: Interpret plant water relations and nutrients<br>CO3: Identify the role of micro and macronutrients in plant<br>CO4: Examine the role of carbon and nitrogen metabolism<br>CO5: Evaluate the growth and development of plant<br>CO6: Develop a comprehensive understanding of plant physiology | |
| **7** | Course Description | Knowledge regarding anatomy equipped the students to identify different types of tissues and make them able to correlate their physiology in a better away. This will also help them to understand how different plant tissue evolve and modify their structure and functions with respect to their environment. | |
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Anatomy** | CO1,CO6 |
| | A | The shoot and root apical meristem and its histological organization | |
| | B | simple & complex permanent tissues, primary structure of shoot & root | |
| | C | secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf) | |
| | **Unit 2** | **Plant water relations and nutrients** | CO2, CO6 |
| | A | Plant water relations: Importance of water to plant life | |
| | B | Diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, | |
| | C | stomata & their mechanism of opening & closing. | |
| | **Unit 3** | **Micro & macro nutrients** | CO3, CO6 |
| | A | Essential and non-essential Micro & macronutrients: criteria for identification of essentiality of nutrients | |

| | | | |
|---|---|---|---|
| | B | roles and deficiency systems of nutrients | |
| | C | mechanism of uptake of nutrients, mechanism of food transport | |
| | **Unit 4** | **Carbon and nitrogen metabolism** | CO4, CO6 |
| | A | Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, Calvin cycle, | |
| | B | CAM plants, photorespiration, compensation point | |
| | C | Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants | |
| | **Unit 5** | **Growth and development** | CO5, CO6 |
| | A | Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene) | |
| | B | Physiological role and mode of action, seed dormancy and seed germination | |
| | C | concept of photoperiodism and vernalization | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.<br>Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK. | |
| | Other References | Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.<br>Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.<br>Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4Th edition, W.H. Freeman and Company, New York, USA.<br>Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.<br>Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | - | 2 | 1 | 3 | 1 | 2 | 2 | 1 | 3 | 2 |
| **CO2** | 2 | 2 | 2 | - | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 3 | 2 |
| **CO3** | 2 | 2 | 2 | - | 2 | 2 | 3 | 1 | 1 | 1 | 3 | 3 | 2 |
| **CO4** | 2 | 2 | 2 | - | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 2 |
| **CO5** | 2 | 2 | 2 | - | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 2 |
| **CO6** | 2 | 3 | 3 | - | 3 | 2 | 3 | 1 | 3 | 3 | 1 | 3 | 2 |
| **Avg** | 2.0 | 2.2 | 2.2 | - | 1.8 | 1.7 | 3.0 | 1.0 | 1.7 | 1.5 | 1.5 | 3.0 | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: FST314** **Course Title: Food Waste Management**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2023-2024** | |
| **Branch: Biotechnology** | | **SEMESTER: V** | |
| **1** | Course Code | FST314 | |
| **2** | Course Title | Food Waste Management | |
| **3** | Credits | 3 | |
| **4** | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | DSE | |
| **5** | Course Objective | • Understanding the food industry waste.<br>• Importance and need of management the industrial waste.<br>• Various treatment methods available for food waste.<br>• Types, availability and utilization of by-products from waste.<br>• Bio methanation and bio composting technology for organic waste utilization<br>• Industrial waste treatments and ways for waste disposal method.<br>• Food Additives; Food Adulteration | |
| **6** | Course Outcomes | After successful completion of this course students will be able to:<br>CO1: Define the basic concept of waste and types.<br>CO2: Illustrate the waste disposal method. Recognize the importance and utility of waste from food Industry<br>CO3: Develop the treatment of plant waste by physical, chemical, and biological methods, Effluent treatment plants, Use of waste and waste water. Various hazards and their control measures.<br>CO4: Compare the types, availability, and utilization of by-products of cereals, legumes & oilseeds, Utilization of by-products from food processing Industries.<br>CO5: Explain status and utilization of dairy by-products. Industrial waste management<br>CO6: Case study. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction** | CO1, CO6 |
| | A | Classification and characterization of food industrial wastes from fruit and vegetable processing industry, beverage industry, fish, meat and poultry industry, sugar industry and dairy industry; | |
| | B | Waste disposal methods – physical, chemical and biological; Economical aspects of waste treatment and disposal. | |
| | C | Identification of waste | |
| | **Unit 2** | **Treatment methods for liquid wastes** | CO2, CO6 |
| | A | Treatment methods for liquid wastes, Treatment methods from food process industries; | |
| | B | Design of activated sludge process, | |

| | | | |
|---|---|---|---|
| | C | Rotating biological contactors, Trickling filters, UASB, Biogas plant. | |
| | **Unit 3** | **Treatment methods of solid wastes** | CO3, CO6 |
| | A | Treatment methods of solid wastes,<br>Biological composting, drying and incineration;<br>Design of solid waste, management system: Landfill digester, Vermicomposting pit. | |
| | B | Treatment methods of solid wastes,<br>Biological composting, drying and incineration;<br>Design of solid waste, management system: Landfill digester, Vermicomposting pit. | |
| | C | Treatment methods of solid wastes,<br>Biological composting, drying and incineration;<br>Design of solid waste, management system: Landfill digester, Vermicomposting pit. | |
| | **Unit 4** | **Bio filters and bio clarifiers** | CO4, CO6 |
| | A | Bio filters and bio clarifiers, | |
| | B | Ion exchange treatment of waste water, | |
| | C | Drinking-water treatment, Recovery of useful materials from effluents by different methods | |
| | **Unit 5** | **Case Studies** | CO5, CO6 |
| | A | Cane Sugar waste, molasses for alcohol, | |
| | B | Baggasse for paper pulp, chemicals, bioethanol, cogeneration | |
| | C | Milk Industry Case studies | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA: 25% | MTE: 25% | ETE: 75% |
| | Text book/s* | 1.Handbook of Waste management and co-product recovery in Food Processing – Vol.1-Keith Waldron | |
| | Other References | 1. Food Industry Wastes: Disposal and Recovery; Herzka A & Booth RG; 1981, Applied Science Pub Ltd. | |

**CO-PO PSO Mapping**

| CO/PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 1 | - | 1 | 1 | 2 | 1 | 2 | 1 | - | - | 2 |
| **CO2** | 3 | 1 | - | - | 1 | 2 | 2 | 1 | 2 | 1 | - | - | 2 |
| **CO3** | 3 | 2 | 1 | - | 1 | 3 | 3 | 2 | 2 | 2 | - | - | 2 |
| **CO4** | 3 | 2 | 2 | - | 1 | 3 | 3 | 2 | 2 | 1 | - | - | 2 |
| **CO5** | 3 | 2 | 1 | - | 1 | 3 | 3 | 2 | 2 | 2 | - | - | 2 |
| **CO6** | 3 | 3 | 3 | - | 1 | 3 | 3 | 2 | 2 | 1 | - | - | 2 |
| **Avg** | 3.0 | 1.8 | 1.6 | - | 1.0 | 2.5 | 2.7 | 1.7 | 2.0 | 1.3 | - | - | 2.0 |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

**Course code: BBI303** **Course Title: Animal Diversity Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-2026** |
| **Branch: Biotechnology** | | **SEMESTER: V** |
| **1** | Course Code | **BBI303** |
| **2** | Course Title | **Animal Diversity Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | Compulsory |
| **5** | Course Objective | This course has been designed to make students understand the basic characteristics and the diversity of invertebrate animals. They learn the taxonomic relationships and major features of selected phyla and classes of animals.<br>2) Understand how very different organisms can have a basic set of answers to shared physiological problems.<br>3) Understand when similarities between structures are based on shared history (homology) or convergence |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Name the protozoans specimen.<br>CO2: Understand the cnidara and acnidaria specimen.<br>CO3: Identify platyhelminthes by its physical characteristic<br>CO4: Analyze nemathelminthes by its physical characteristic<br>CO5: Evaluate the annelida physical characteristics<br>CO6: Discuss invertebrates animal diversity |
| **7** | Course Description | **Students appreciates and understand of the variety of animal life.They** Study the relationship between structure and function. In other words, they will be able to relate the anatomy (the structure of an organism) to the physiology (the biological function) of its organs and organ systems. |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Protozoans** | |
| | A | To identify specimens of Protozoans | CO1, CO6 |
| | B | List out distinguishing characteristics of Protozoans | CO1,CO6 |
| | C | Virtual Lab: https://www.vlab.co.in<br>https://virtualmicroscopy.peabody.yale.edu/ | CO1,CO6 |
| | **Unit 2** | **Cnidaria and Acnidaria** | |

| | | | | | |
|---|---|---|---|---|---|
| | A | To identify specimens of Cnidaria and Acnidaria | | | CO2, CO6 |
| | B | List out distinguishing characteristics of Cnidaria and Acnidaria | | | CO2, CO6 |
| | C | Virtual Lab: https://www.vlab.co.in<br>https://virtualmicroscopy.peabody.yale.edu/ | | | CO2, CO6 |
| | **Unit 3** | **Platyhelminthes** | | | |
| | A | To identify specimens of Platyhelminthes | | | CO3, CO6 |
| | B | List out distinguishing characteristics of Platyhelminthes | | | CO3, CO6 |
| | C | Virtual Lab: https://www.vlab.co.in<br>https://virtualmicroscopy.peabody.yale.edu/ | | | |
| | **Unit 4** | **Nemathelminthes** | | | |
| | A | To identify specimens of Nemathelminthes | | | CO4, CO6 |
| | B | List out distinguishing characteristics of Nemathelminthes | | | CO4, CO6 |
| | C | Virtual Lab: https://www.vlab.co.in<br>https://virtualmicroscopy.peabody.yale.edu/ | | | CO4, CO6 |
| | **Unit 5** | **Annelida** | | | |
| | A | To identify specimens of Annelida | | | CO5, CO6 |
| | B | List out distinguishing characteristics of Annelida | | | CO5, CO6 |
| | C | Virtual Lab: https://www.vlab.co.in<br>https://virtualmicroscopy.peabody.yale.edu/ | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | 1. 1. Modern Textbook of Zoology Invertebrates by R.L. Kotpal – (Rastogi Publications, Meerut, 10th Revised Edition).<br>2. 2. Invertebrate Zoology series (Protozoa to Echinodermata) by R.L. Kotpal – (Rastogi Publications, Meerut).<br>3. 3. Invertebrate Zoology by E.L.Jordon and P.S. Verma – S. Chand & Co., Delhi).<br>4. 4. Invertebrate Zoology by J.K. Dhami and P.S. Dhami – S. Chand & Co., Delhi).<br>5. 5. A Textbook of Invertebrate Zoology by S.N. Prasad – (Kitab Mahal, Allahabad).<br>6. 6. Life of Invertebrates by Russel and Hunter – (Macmillan) | | | |
| | Reference books | 1. Invertebrate Zoology by R.D. Barnes – (W.B.Saunders, Philadelphia)<br>2. A manual of Zoology, Vol.1 by Ekambernatha Ayyar (Vishwanathan, Madras) | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | 3 | 3 | - | 2 | 2 | 1 | - | 1 |
| **CO2** | - | - | - | - | - | 3 | 3 | - | 1 | 2 | 1 | - | 1 |
| **CO3** | - | - | - | - | - | 3 | 3 | - | 1 | 2 | 3 | - | 1 |
| **CO4** | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 | - | 2 |
| **CO5** | - | - | - | - | - | 3 | 3 | - | 1 | 1 | 1 | - | 2 |
| **CO6** | - | - | - | - | - | 3 | 3 | 1 | 2 | 2 | 1 | - | 2 |
| **Avg** | - | - | - | - | - | 2.7 | 2.7 | 1.0 | 1.3 | 1.8 | 1.5 | - | 1.5 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI305** **Course Title: Plant Anatomy & Physiology Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-2026** |
| **Branch: Biotechnology** | | **SEMESTER: V** |
| **1** | Course Code | **BBI305** |
| **2** | Course Title | **Plant Anatomy & Physiology Lab** |
| **3** | Credits | **2** |
| **4** | Contact Hours (L-T-P) | **0-0-4** |
| | Course Status | Compulsory |
| **5** | Course Objective | Objective of the course is to understand and practically able to identify monocot or dicot plant<br>Able to understand the physiology of plant |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: To define the anatomy of monocot and dicot<br>CO2: Demonstrate plasmolysis<br>CO3: To identify closing and opening of stomata<br>CO4: To analyze the technique to separate the pigments<br>CO5: To evaluate the nodules preparation<br>CO6: To develop a comprehensive understanding of plant anatomy and physiology |
| **7** | Course Description | The labs are intended to help students visualize main basic concepts and common techniques in plant anatomy and physiology). Students will learn basic data analysis techniques and how to interpret results from simple experiments. |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Monocot and Dicot** | |
| | A | Preparation of stained mounts of anatomy of monocot and dicot's root, | CO1, CO6 |
| | B | Preparation of stained mounts of anatomy of monocot and dicot's stem | CO1,CO6 |
| | C | Preparation of stained mounts of anatomy of monocot and dicot leaf. | CO1,CO6 |
| | **Unit 2** | **Plasmolysis** | |
| | A | Introduction and principle of plasmolysis | CO2, CO6 |
| | B | Demonstration of plasmolysis by *Tradescantia* leaf peel | CO2, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | C | Virtual lab on plasmolysis | | | CO2, CO6 |
| | **Unit 3** | **Stomata** | | | |
| | A | Introduction, functions and importance of stomata | | | CO3, CO6 |
| | B | Demonstration of opening & closing of stomata | | | CO3, CO6 |
| | C | Virtual lab on stomata functioning | | | |
| | **Unit 4** | **Pigments** | | | |
| | A | Introduction to pigments | | | CO4, CO6 |
| | B | Separation of photosynthetic pigments by paper chromatography | | | CO4, CO6 |
| | C | Virtual Lab on pigments by HPLC | | | CO4, CO6 |
| | **Unit 5** | **Root Nodules** | | | |
| | A | Introduction and importance of leguminous plant | | | CO5, CO6 |
| | B | Preparation of root nodules from a leguminous plant | | | CO5, CO6 |
| | C | Virtual lab on root nodules | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.<br>2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.<br>3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.<br>4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons. | | | |
| | Reference books | Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4Th edition, W.H. Freeman and Company, New York, USA.<br>Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd. | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | - | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| **CO2** | 1 | 2 | 2 | - | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| **CO3** | 1 | 2 | 2 | - | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| **CO4** | 1 | 2 | 2 | - | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| **CO5** | 1 | 2 | 2 | - | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| **CO6** | 2 | 3 | 3 | - | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 1 | 3 |
| **Avg** | 1.2 | 2.2 | 2.2 | - | 1.8 | 1.2 | 2.2 | 1.2 | 2.2 | 1.2 | 2.2 | 1.0 | 2.2 |

| | | | | |
|---|---|---|---|---|
| **School:** SSBSR | | **Batch:** 2023-27 | | |
| **Programme:** B.Sc | | **Year** 3rd | | |
| **Branch:** Biotechnology | | **Semester** V | | |
| 1 | Course Code | | | |
| **2** | Course Title | Industry Connect | | |
| 3 | Credits | 2 | | |
| 4 | Contact Hours(L-T-P) | 0-0-4 | | |
| | Course Status | Compulsory | | |
| 5 | Course Objective | This course will expose students to apply theories learned in the classroom and provides current technological developments relevant to the subject area of training. Students will be able to identify the career preferences and professional goals. | | |
| 6 | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Get familiarize with industry principles and practices.<br>CO2: Identify and analyze an appropriate problem.<br>CO3: Develop teamwork and apply prior acquired knowledge in problem solving.<br>CO4: Demonstrate effective verbal and written communication skills.<br>CO5: Practice scientists' responsibilities, self-understanding, self-discipline and ethical standards.<br>CO6: Identify the career preferences and professional goals. | | |
| 7 | Course Description | The Internship aims to offer students the opportunity to apply their prior acquired knowledge in problem solving. Students will acquire skills important for time management, discipline, self learning, and effective communication and so on. | | |
| 8 | **Outline syllabus** | | | **CO Mapping** |
| | **Unit 1** | | | |
| | A, B, C | Define objectives and conditions for the internship, ensuring students that it is related to the study path carried out at the University | | CO1,CO6 |
| | **Unit 2** | | | |
| | A, B, C | Problem Definition and identification, Team/Group formation and Project Assignment. Finalizing the problem statement, resource requirement, if any. | | CO2,CO6, |
| | **Unit 3** | | | |
| | A, B, C | The internship work plan is drawn up by developing team work and applies prior acquired knowledge in problem solving. | | CO3,CO6, |
| | **Unit 4** | | | |
| | A, B, C | Demonstrate and execute Project with the team. Submission of evaluation form and final report completed by the intern. | | CO4,CO6 |
| | **Unit 5** | | | |
| | A, B, C | Final evaluation form completed by the supervisor at the Host Organization and final presentation before departmental committee. | | CO5,CO6 |
| | Mode of examination | Jury+Practical+Viva | | |
| | Weightage Distribution | Internal | External | |
| | | 25% | 75 % | |
| | Text book/s* | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 |
| **CO2** | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO3** | - | - | 1 | - | 1 | 2 | 3 | 3 | 3 | 2 | 3 | 1 | 3 |
| **CO4** | - | - | 3 | 1 | - | 2 | 1 | 3 | 3 | 2 | 2 | 1 | 2 |
| **CO5** | - | - | 3 | - | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 2 |
| **CO6** | 1 | 1 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **Avg** | 1.3 | 1.3 | 2.0 | 1.3 | 2.0 | 2.2 | 2.7 | 2.8 | 2.7 | 2.2 | 2.3 | 1.2 | 2.3 |

**1. Slight (Low)** **2. Moderate (Medium)** **3. Substantial (High)**

**Course code: RBL003** **Course Title: Research Based Learning-III**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2022-23** |
| **Branch: Biotechnology** | | **SEMESTER: V** |
| **1** | Course Code | **RBL003** |
| **2** | Course Title | **Research Based Learning III** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | Compulsory |
| **5** | Course Objective | Develop knowledge of a specific area of specialization.<br>Develop research skills especially in biological experiments, project writing and oral presentation |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>**CO1:** Relate the understanding of various research articles to identify research gap on a given topic<br>**CO2:** Illustrate line of approach to overcome the research gap<br>**CO3:** Identify appropriate method/s uitable for a given problem<br>**CO4:** Analyze characterization techniques/ theoretical analysis for obtaining result<br>**CO5:** Explain graphs, diagrams, flowchart etc.<br>**CO6:** Compile research findings in written and verbal forms |

| 8. | Outline syllabus | | | | CO Mapping |
|---|---|---|---|---|---|
| | **Unit 1** | Introduction to various research problems | | | **CO1,CO6** |
| | **Unit 2** | Identify a research question | | | **CO2,CO6** |
| | **Unit 3** | Literature survey | | | **CO3,CO6** |
| | **Unit 4** | Report writing | | | **CO4,CO6** |
| | **Unit 5** | Presentation | | | **CO5 ,CO6** |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | | CA | CE | ESE | |

| | | | | | |
|---|---|---|---|---|---|
| | Weightage Distribution | 25% | 25% | 50% | |
| | Text books | 10 Recent International Journal Articles of repute. | | | |
| | Reference books | | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 3 | 1 | 3 | 1 | 2 | 3 | 2 | 2 | 3 | 1 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | 2 | 2 | 1 | 2 |
| CO5 | 1 | - | 1 | 3 | - | - | - | 3 | 1 | 1 | 1 | 1 | 1 |
| CO6 | 1 | 1 | 1 | 3 | 1 | - | 1 | 3 | 1 | 2 | 2 | 1 | 2 |
| Avg | 1.7 | 1.6 | 1.8 | 2.0 | 2.0 | 1.5 | 2.2 | 2.8 | 1.8 | 1.8 | 2.3 | 1.5 | 2.0 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

# SEMESTER VI

**Course code: BBI312** **Course Title: Fundamentals of Plant Biotechnology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-26** | |
| **Branch: Biotechnology** | | **SEMESTER: VI** | |
| **1** | Course Code | BBI312 | |
| **2** | Course Title | **Fundamentals of Plant Biotechnology** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1. To introduce students with the basic concepts and techniques involved in Plant Biotechnology<br>2. Learn how applications of Plant Biotechnology are applied for human, social and environmental welfare | |
| **6** | Course Outcomes | The student will be able to understand following purposes:<br>CO1: Memorize the concept of totipotency<br>CO2: Describe the concept of culture media for plants and its formulations.<br>CO3: Execute the culturing methods in Plant tissue culture.<br>CO4: Differentiate between the process of zygotic and somatic embryogenesis.<br>CO5: Appraise the process of micro propagation and its utility.<br>CO6: Develop the production and optimization of secondary metabolites by using different cultural techniques | |
| **7** | Course Description | Help student to understand the concept of totipotency, culture media for plants, its formulations and the culturing methods in Plant Tissue Culture. The student will be able to explain the process of embryogenesis, demonstrate the process of micropropagation and its utility. Student will learn about optimized production of secondary metabolites by using culture techniques | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction of plant Biotechnology** | CO1,CO6 |
| | A | History of plant tissue culture | |
| | B | Concept of totipotency | |
| | C | Media composition & Growth Hormones | |
| | **Unit 2** | **Culture Initiation and Organogenesis;** | CO2, CO6 |
| | A | Explant; Callus Initiation maintenance of callus, Subculture Cytodifferentiation- advantage and disadvantage | |
| | B | Somatic embryogenesis; transfer and establishment of whole plants in soil (hardening) Rapid clonal propagation and production of virus -free plant | |

| | | | |
|---|---|---|---|
| | C | In vitro pollination; embryo culture and embryo rescue. Protoplast fusion, selection of hybrid cells; symmetric and asymmetric hybrids, cybrids | |
| | **Unit 3** | **Somatic Embryogenesis and Nuclear cytology of cultured plant cells and somaclonal variations** | CO3, CO6 |
| | A | Somatic and zygotic embryo Process of embryogenesis; isolation of protoplast & its Fusion | |
| | B | Somatic and zygotic embryo; Production of haploid plants and their utilization | |
| | C | Cryopreservation and slow growth for germplasm conservation. Production of Biochemicals from cells and tissue cultures | |
| | **Unit 4** | **Micro propagation and Gene transfer in nuclear genome and chloroplasts** | CO4, CO6 |
| | A | Micro propagation technique, Purpose of micro propagation, Factors responsible for micro propagation. | |
| | B | Agrobacterium-mediated gene transfer, direct gene transfer, antibiotic marker-free transgenics | |
| | C | Transgenic plants: insect resistance, virus resistance, abiotic stress tolerance, longer shelf life. Strategies for suppression of endogenous genes), male sterility, enhanced nutrition (golden rice). | |
| | **Unit 5** | **Production of Secondary Metabolism** | CO5, CO6 |
| | A | Concept of Primary & Secondary metabolites | |
| | B | Production and optimization of secondary metabolites | |
| | C | Hairy root culture: Advantages, Disadvantages | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Bhojwani S.S., Dantu P.K., "Plant Tissue Culture: An Introductory Text", Springer, 2013 | |
| | Other References | Stewart C.N., "Plant Biotechnology and Genetics: Techniques and Applications", Wiley-nterscience'2008 | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | - | 1 | 1 | 2 | 2 | 2 | 1 | 1 | - | 1 |
| **CO2** | 3 | 2 | 2 | - | 1 | 2 | 2 | 2 | 2 | 1 | 1 | - | 2 |
| **CO3** | 3 | 2 | 3 | - | 3 | 2 | 2 | 2 | 3 | 3 | 2 | - | 3 |
| **CO4** | 3 | 1 | 2 | - | 2 | 1 | 1 | 1 | 1 | 1 | 1 | - | 3 |
| **CO5** | 3 | 2 | 2 | - | 1 | 2 | 1 | 2 | 3 | 3 | 1 | - | 3 |
| **CO6** | 3 | 3 | 2 | - | 2 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 |
| **Avg** | 3.0 | 2.0 | 2.0 | - | 1.7 | 1.8 | 1.8 | 2.0 | 2.3 | 2.0 | 1.5 | - | 2.5 |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch: 2023-2027** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-26** | |
| **Branch: Biotechnology** | | **Semester: 06** | |
| 1 | Course Code | BBI313 | |
| 2 | Course Title | **Fundamentals of Environmental Microbiology** | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | Course is designed to introduce students to understand environmental concepts, principals and the world of microorganisms from the point-view of interaction and reaction of microbial impacts and role of microorganisms in the environment. | |
| 6 | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Understand the Microorganisms and their Habitats.<br>CO2: Know about the Microbial Interactions.<br>CO3: Explain about Biogeochemical Cycling.<br>CO4: Understand the Waste Management.<br>CO5: Know about the Microbial Bioremediation.<br>CO6: Important Waste potability. | |
| 7 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Microorganisms and their Habitats** | |
| | A | Structure and function of ecosystems.<br>Terrestrial Environment: Soil profile and soil microflora. Aquatic Environment: Microflora of fresh water and marine habitats. | CO1, CO6 |
| | B | Atmosphere: Aeromicroflora and dispersal of microbes<br>Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.<br>Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, | |
| | C | Salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter | |
| | **Unit 2** | **Microbial Interactions** | |
| | A | Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism,<br>Predation, Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. | CO2, CO6 |
| | B | Microbe-animal interaction: Microbes in ruminants | |

| | | | |
|---|---|---|---|
| | C | Nematophagus fungi and symbiotic luminescent bacteria | |
| | **Unit 3** | **Biogeochemical Cycling** | CO3, CO6 |
| | A | Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin | |
| | B | Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction<br>Phosphorus cycle: Phosphate immobilization and solubilization | |
| | C | Sulphur cycle: Microbes involved in sulphur cycle<br>Other elemental cycles: Iron and manganese | |
| | **Unit 4** | **Waste Management** | |
| | A | **Solid Waste management:** Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) | CO4, CO6 |
| | B | **Liquid waste management:** Composition and strength of sewage (BOD and COD), | |
| | C | Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment. | |
| | **Unit 5** | **Microbial Bioremediation** | CO5, CO6 |
| | A | (Principles and degradation of common pesticides, organic hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants. | |
| | B | **Water Potability**<br>Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: | |
| | C | Presumptive test/MPN test, confirmed and completed tests for fecal coliforms (b) Membrane filter technique and (c) Presence/absence tests. | |
| | Mode of examination | **Theory** | |
| | Weightage Distribution | CA: 25% / MSE: 25% / ESE: 75% | |
| | Text book/s* | Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA<br>Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 1 | - | - | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 3 | 1 | 1 | - | - | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO3** | 3 | 1 | 1 | - | - | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| **CO4** | 3 | 2 | 2 | - | - | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO5** | 3 | 2 | 2 | - | - | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 2 |
| **CO6** | 3 | 3 | 3 | - | - | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 2 |
| **Avg** | 3.0 | 1.7 | 1.7 | - | - | 2.5 | 1.7 | 1.7 | 2.0 | 1.3 | 1.5 | 1.2 | 1.5 |

**1. Slight (Low)** **2. Moderate (Medium)** **3. Substantial (High)**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-26** | |
| **Branch: Biotechnology** | | **SEMESTER: VI** | |
| **1** | Course Code | **BBI311** | |
| **2** | Course Title | **Application of Animal Biotechnology** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1. This course provides a comprehensive introduction to fundamentals and applications of animal biotechnology.<br>2. The course is designed to give students an up-to-date understanding of a wide array of techniques that are used in animal cell culture, tissue culture and organ culture.<br>3. This course also focuses on stem cell culture and their applications.<br>4. The course also highlights the potential of transgenic animals to improve human welfare. | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Introduction to the concept of animal cell culture<br>CO2: Describe the development of the cell lines in different media.<br>CO3: Execute the different methods of animal cell cloning.<br>CO4: Demonstrate the technology of stem cell culture.<br>CO5: Application of animal cell culture technology.<br>CO6: Learn the animal cell cultural techniques and understand its application in research domain. | |
| **7** | Course Description | The aim of this course is to provide better understanding about the animal cell culture and its types. The student gets acquainted with the various types of media used in animal cell culture and about the types of cell lines. It briefs about the applications of cell culture and transgenic animals | |
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Animal Cell Culture** | CO1,CO6 |
| | A | Structure and organization of animal cell; sources of cell | |
| | B | Techniques of obtaining cells by disaggregation of tissues, Enzymatic disaggregation | |
| | C | EDTA treatment; Types of cell culture, Equipment required for animal cell culture | |
| | **Unit 2** | **Development of Cell Lines** | CO2, CO6 |
| | A | Medium preparations and its various types Natural, artificial serum protein free media | |
| | B | Advantages and disadvantages of sub culturing techniques, viable cell counts with hemocytometer, development of cell lines | |

| | | | |
|---|---|---|---|
| | C | Types of cell lines, their characteristics, suspension culture advantages & culture. Disadvantages, totipotency in animal cell | |
| | **Unit 3** | **Animal Cell Cloning** | CO3, CO6 |
| | A | Cloning, types of cell cloning methods of cloning | |
| | B | Transfection; methods, retro-virus mediated gene transfer | |
| | C | Embryonic stem cell-mediated gene transfer, artificial twining, risk of cloning cloned animals. | |
| | **Unit 4** | **Stem Cell Culture and Technology** | CO4, CO6 |
| | A | Stem cell technology; hematopoiesis, methods to study repopulation assay. | |
| | B | In vitro cloning assay, long term culture. | |
| | C | Embryonic stem cell culture, Application of stem cell culture. | |
| | **Unit 5** | **Application of Animal Cell Culture Technology** | CO5, CO6 |
| | A | Transgenic cells and animals & their application; | |
| | B | organ culture, Histotypic & organotypic culture, rearing animal models and advantages | |
| | C | Potential of transgenic animals to improve human welfare in Agriculture, medicine and industry, ethical and value issues in animal biotechnology | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Shenoy M., "Animal Biotechnology", Laxmi Pub, 2007. | |
| | Other References | Jenkins N., "Animal Cell Biotechnology: Methods and Protocols", Humana Press, 2006. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 1 | - | 1 | - | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| **CO2** | 2 | 2 | 1 | - | 1 | - | 1 | 1 | 2 | 1 | 2 | 2 | 1 |
| **CO3** | 2 | 2 | 2 | - | 1 | - | 1 | 2 | 2 | 2 | 2 | 3 | 2 |
| **CO4** | 2 | 2 | 2 | 1 | 1 | - | 2 | 2 | 3 | 2 | 2 | 3 | 2 |
| **CO5** | 3 | 2 | 2 | 1 | 2 | - | 2 | 2 | 3 | 2 | 3 | 3 | 2 |
| **CO6** | 3 | 3 | 3 | 1 | 2 | - | 2 | 2 | 3 | 2 | 3 | 3 | 3 |
| **Avg** | 2.5 | 2.0 | 1.8 | 1.0 | 1.3 | - | 1.5 | 1.7 | 2.5 | 1.7 | 2.2 | 2.5 | 1.8 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBI314 Course Title: Application of Animal Biotechnology Laboratory**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-2026** |
| **Branch: Biotechnology** | | **SEMESTER: VI** |
| **1** | Course Code | **BBI314** |
| **2** | Course Title | **Application of Animal Biotechnology Laboratory** |
| **3** | Credits | **2** |
| **4** | Contact Hours (L-T-P) | **0-0-4** |
| | Course Status | Compulsory |
| **5** | Course Objective | To learn methods of cell isolation and culturing of cell lines |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Identify standard operating procedures for laboratory equipments and sterilization of glasswares.<br>CO2: Preparation of growth media and salt solution for cell lines.<br>CO3: Illustrate the technique to culture lymphocytes<br>CO4: Explain and perform the protocol to extract DNA from animal tissues and assess the purity and size of DNA<br>CO5: Important measures taken to preserve the cells<br>CO6: Able to isolate, culture and maintain the cells |
| **7** | Course Description | To Plan and carry out the experiment and to learn methods of cell isolation from tissues and maintain the cell lines on the media. DNA extraction from tissue and identify the DNA band on gel electrophoresis |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Sterilization techniques** | |
| | A | Theory and Practical: Glassware sterilization | CO1, CO6 |
| | B | Media sterilization, Laboratory sterilization | CO1,CO6 |
| | C | Sources of contamination and decontamination measures | CO1,CO6 |
| | **Unit 2** | **Media Preparation** | |
| | A | Preparation of Hanks Balanced salt solution | CO2, CO6 |
| | B | Preparation of Minimal Essential Growth medium | CO2, CO6 |
| | C | To prepare MEM medium for the animal cell culture | CO2, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | **Unit 3** | **Isolation of lymphocytes for culturing** | | | |
| | A | Buffer preparations | | | CO3, CO6 |
| | B | Isolation of lymphocytes for culturing | | | CO3, CO6 |
| | C | To passage / subculture the cells in order to maintain them viable for extended period of time. | | | |
| | **Unit 4** | **DNA isolation** | | | |
| | A | DNA isolation from animal tissue | | | CO4, CO6 |
| | B | Quantification of isolated DNA. | | | CO4, CO6 |
| | C | Resolving DNA on Agarose Gel. | | | CO4, CO6 |
| | **Unit 5** | **Preservation** | | | |
| | A | Buffers preparation | | | CO5, CO6 |
| | B | To preserve the given cell culture for a long period using cryopreservation. | | | CO5, CO6 |
| | C | Passage the cells from preserved vial | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | Freshney R.I., "Culture of Animal Cells: A Manual of Basic Technique", Wiley-Liss, 2005.<br>Boyer R.F., "Biochemistry Laboratory: Modern Theory and Techniques", Prentice Hall, 2011. | | | |
| | Reference books | Jenkins N., "Animal Cell Biotechnology: Methods and Protocols", Humana Press, 2006. | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | - | 2 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 2 |
| **CO2** | 1 | 3 | 2 | - | 2 | 1 | 2 | 1 | 2 | 1 | 3 | 2 | 2 |
| **CO3** | 1 | 2 | 3 | - | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 3 |
| **CO4** | 1 | 2 | 2 | - | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 3 | - | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO6** | 1 | 3 | 3 | - | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| **Avg** | 1.2 | 2.3 | 2.5 | - | 2.2 | 1.5 | 1.8 | 1.3 | 2.2 | 1.7 | 2.8 | 2.2 | 2.7 |

**1. Slight (Low)** **2. Moderate (Medium)** **3. Substantial (High)**

**Course code: BBI315** **Course Title: Fundamentals of Plant Biotechnology Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-2026** |
| **Branch: Biotechnology** | | **SEMESTER: VI** |
| **1** | Course Code | **BBI315** |
| **2** | Course Title | **Fundamentals of Plant Biotechnology Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | Compulsory |
| **5** | Course Objective | To learn methods of plant tissue culture. |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Understand the concept of Plant cell culture.<br>CO2: To learn the cell culture practices.<br>CO3: Demonstrate the sterilization techniques<br>CO4: Illustrate the techniques to isolate single cell<br>CO5: Assess and regenerate the plant in laboratory conditions<br>CO6: Design and conduct an experiment. |
| **7** | Course Description | To Plan and carry out the experiment and to learn methods of plant tissue. To be able to extract DNA from plant. |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Introduction to Plant tissue culture** | |
| | A | Good Lab Practices in Plant tissue culture | CO1, CO6 |
| | B | Techniques in Plant Tissue Culture | CO1,CO6 |
| | C | To Prepare the material required for various cell culture practices in sterile conditions | CO1,CO6 |
| | **Unit 2** | **Sterilization Techniques** | |
| | A | Media components and preparations | CO2, CO6 |
| | B | Sterilization techniques and Inoculation of various explants | CO2, CO6 |
| | C | Aseptic manipulation of various explants | CO2, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | **Unit 3** | **Tissue culture sterilization** | | | |
| | A | Preparation of buffers | | | CO3, CO6 |
| | B | Preparation of tissue culture media | | | CO3, CO6 |
| | C | Sterilization of Plant Materials | | | |
| | **Unit 4** | **Plant cell Culture** | | | |
| | A | Preparation of buffers | | | CO4, CO6 |
| | B | Isolation from single cells from intact plant organs | | | CO4, CO6 |
| | C | Single cell culture | | | CO4, CO6 |
| | **Unit 5** | **Plant regeneration** | | | |
| | A | Preparation of buffers | | | CO5, CO6 |
| | B | Plant regeneration from callus or plant tissue | | | CO5, CO6 |
| | C | Isolation and culture of plant protoplast | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | Plant Cell and Tissue Culture. A Laboratory Manual by Jakob Reinert, Michael Magson Yeoman. 2012 | | | |
| | Reference books | | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| **CO2** | 2 | 2 | 3 | - | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 2 |
| **CO3** | 2 | 2 | 3 | - | 2 | 1 | 1 | 2 | 2 | 3 | 1 | 1 | 2 |
| **CO4** | 2 | 3 | 3 | - | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 1 | 2 |
| **CO5** | 3 | 3 | 3 | - | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 |
| **CO6** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **Avg** | 2.5 | 2.5 | 2.8 | 2.0 | 2.0 | 1.8 | 1.7 | 2.3 | 2.2 | 2.8 | 1.7 | 1.3 | 2.0 |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

**Course code: BSP310 Course Title: Environmental Microbiology Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-2026** |
| **Branch: Biotechnology** | | **SEMESTER: VI** |
| **1** | Course Code | **BSP310** |
| **2** | Course Title | Environmental Microbiology lab |
| **3** | Credits | **2** |
| **4** | Contact Hours (L-T-P) | **0-0-4** |
| | Course Status | Compulsory |
| **5** | Course Objective | Understand the role of microorganisms as agents of environmental change. Recognize microorganisms as indicators of alteration of an ecosystem. To understand the microbial processes aimed to solve environmental problems. |
| **6** | Course Outcomes | After finishing the course, the students will be able to<br>CO1: Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action<br>CO2: Isolation of microbes (bacteria & fungi) from soil<br>CO3: Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.<br>CO4: Illustrate the technique to identify the quality of water.<br>CO5: Assessment of microbes in air<br>CO6: Design and conduct an experiment. |
| **7** | Course Description | Environmental microbiology is designed to introduce students to understand environmental concepts, principals and the world of microorganisms from the point-view of interaction and reaction of microbial impacts and role of microorganisms in the environment |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Soil analysis** | |
| | A | Analysis of soil – pH, percolation, capillary action. | CO1, CO6 |
| | B | moisture content | CO1,CO6 |
| | C | water holding capacity | CO1,CO6 |
| | **Unit 2** | **Isolation of microbes from Soil** | |
| | A | Preparation of media and autoclave | CO2, CO6 |
| | B | Bacteria from soil | CO2, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | C | Fungi from soil | | | CO2, CO6 |
| | **Unit 3** | **Isolation of microbes from rhizosphere** | | | |
| | A | Preparation of media | | | CO3, CO6 |
| | B | Bacteria from rhizosphere | | | CO3, CO6 |
| | C | Fungi from rhizosphere | | | |
| | **Unit 4** | **Assessment of microbiological quality of water.** | | | |
| | A | Sample collection | | | CO4, CO6 |
| | B | Determination of BOD of waste water sample. | | | CO4, CO6 |
| | C | Determination of microbial contamination from water | | | CO4, CO6 |
| | **Unit 5** | **Design and conduct sampling for microbes in air** | | | |
| | A | Media preparation | | | CO5, CO6 |
| | B | Sample collection from the air | | | CO5, CO6 |
| | C | Gram Staining isolated colonies | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | LABORATORY MANUAL OF MICROBIOLOGY AND BIOTECHNOLOGY, 2ND EDITION. Aneja K.R.. Published by Medtech, 2018. | | | |
| | Reference books | | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | - | 2 | 1 | 2 | 1 | 2 | 2 | 2 | - | 2 |
| **CO2** | 2 | 2 | 1 | - | 2 | 1 | 2 | 1 | 1 | 2 | 3 | - | 2 |
| **CO3** | 2 | 2 | 1 | - | 2 | 1 | 3 | 1 | 1 | 2 | 3 | - | 2 |
| **CO4** | 1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 1 | 3 |
| **CO5** | 1 | 2 | 1 | - | 2 | 2 | 2 | 1 | 2 | 2 | 3 | - | 2 |
| **CO6** | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 1 | 3 |
| **Avg** | 1.8 | 2.5 | 1.7 | 1.5 | 2.2 | 1.5 | 2.5 | 1.3 | 1.8 | 2.2 | 2.8 | 1.0 | 2.3 |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

**Course code: RBL004** **Course Title: Research Based Learning-IV**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc.** | | **Current Academic Year: 2025-26** |
| **Branch: Biotechnology** | | **SEMESTER: VI** |
| **1** | Course Code | **RBL004** |
| **2** | Course Title | **Research Based Learning -IV** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | Compulsory |
| **5** | Course Objective | Develop knowledge of a specific area of specialization.<br>Develop research skills especially in biological experiments, project writing and oral presentation |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>**CO1:** Recognize research-based investigation carried out onproblems in physics and interdisciplinary science<br>**CO2:** Comprehend and compare a research article with areview article or a survey-based article<br>**CO3:** Demonstrate capacity to follow research articles<br>**CO4:** Identify concepts of physics referred in research articles<br>**CO5:** Extract important results of research findings<br>**CO6:** Report research findings in written and verbal forms |
| **7** | Course Description | Research-based learning (RBL) aims to promote and develop student compESEncies related to research practice and to benefit students through activities linked to research. This technique implies the application of learning and teaching strategies that link research with teaching |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Introduction to various research problems** | **CO1,CO6** |
| | **Unit 2** | **Identify a research question** | **CO2,CO6** |
| | **Unit 3** | **Literature survey** | **CO3,CO6** |
| | **Unit 4** | **Report writing** | **CO4,CO6** |
| | **Unit 5** | **Presentation** | **CO5 ,CO6** |

| | | | | | |
|---|---|---|---|---|---|
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | 10 Recent International Journal Articles of repute. | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| **CO2** | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| **CO4** | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| **CO5** | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 2 |
| **CO6** | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 |
| **Avg** | 1.5 | 2.0 | 1.5 | 1.8 | 1.2 | 1.0 | 1.7 | 1.8 | 1.8 | 1.2 | 2.3 | 1.7 | 1.7 |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

**Course code:** **Course Title: Community Connect**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-2027** |
| **Programme: B.Sc.** | | **Bachelors in faculty with single major** |
| **Branch: Biotechnology** | | **SEMESTER: VI** |
| 1 | Course Code | |
| 2 | Course Title | **Community connect** |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P) | 0-0-2<br><br>Contact Hours: 15<br>Project/Field Work: 10<br>Assessment: 00<br>Guided Study: 05<br>Total hours: 30 |
| 5 | Course Status | **Survey/Project (**multidisciplinary) |
| 6 | Course Objective | The students at the completion of the course will be able to:<br>1. **Contribute to the holistic development of students** by making them more aware of socially and economically disadvantaged communities and their specific issues<br>2. **Provide more richer context to classrooms**, so as to make them more effective laboratories of learning by aligning them to social realities beyond textbooks<br>3. **Provide scope to faculty members to align their teaching and researchgoals** by giving them ample opportunity to carry out community -oriented projects<br>4. **Ensure that the community connect Programmes provides benefits to communities** in tangible ways so that they may feel perceptibly better off post the interaction and involvement of the Sharda academic community<br>5. **Provide ample opportunity for Sharda University academic community to contribute** effectively to society and nation building |
| 7 | Course Outcomes | The student upon the completion of the course will be able to:<br>**CO1:** Students learn to be sensitive to the living challenges of disadvantaged communities.<br>**CO2:** Students learn to appreciate societal realities beyond textbooks and classrooms<br>**CO3:** Students learn to apply their knowledge via research, and training forcommunity benefit<br>**CO4:** Students learn to work on socio-economic projects with teamwork and timely delivery<br>**CO5:** Students learn to engage with communities for meaningful contribution tosociety |

| | | | |
|---|---|---|---|
| 8 | Course Description | To connect with the community and able to understand the prevailing issues in the society. | |
| 9 | **Theme** | **Major themes for research:**<br>1. ***Survey and self-learning***: In this mode, students will make survey, analyze data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc.<br>2. ***Survey and solution providing***: In this mode, students will identify the commonproblems and will provide solution/ educate rural population. E.g. air and water pollution, need of after treatment, use of renewable (mainly solar) energy, electricity saving devices, inefficiencies in cropping system, animal husbandry, poultry, pest control, irrigation, machining in agriculture etc.<br>3. ***Survey and reporting***: In this mode students will educate villagers and survey theground level status of various government schemes meant for rural development. The analyzed results will be reported to concerned agencies which will help themfor taking necessary/corrective measures. E.g. Pradhan Mantri Jan Dhan Yojana,Pradhan Mantri MUDRA Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana, Atal pension Yojana, Pradhan Mantri Awas Yojana, Pradhan Mantri FasalBima Yojana, Swachh Bharat Abhiyan, Soil Health Card Scheme, Digital India, Skill India Programme,BetiBachao, BetiPadhao Yojana, DeenDayal Upadhyaya Gram Jyoti Yojana, Shyama Prasad Mukherjee Rurban Mission, UJWAL Discom Assurance Yojana, PAHAL,Pradhan Mantri Awas Yojana-Gramin, Pradhan Mantri Yuva Yojana, Pradhan Mantri Jan Aushadhi Yojana, Pradhan Mantri KhanijKshetra Kalyan Yojana, Pradhan Mantri Suraksha Bima Yojana, UDAN scheme, DeenDayal Upadhyaya Grameen Kaushalya Yojana, Pradhan Mantri Sukanya Samriddhi Yojana, Sansad Adarsh Gram Yojana, Pradhan Mantri SurakshitMatritva Abhiyan, Pradhan Mantri RojgarProtsahan Yojana, Midday Meal Scheme, Pradhan Mantri Vaya Vandana Yojana, Pradhan Mantri MatritvaVandana Yojana, and Ayushman Bharat Yojana. | |
| 9.1 | **Guidelines for Faculty Members** | It will be a group assignment.<br>There should be not more than 10 students in each group.<br>The faculty guide will guide the students and approve the project title and help the studentin preparing the questionnaire and final report.<br>The questionnaire should be well design and it should carry at least 20 questions (Includingdemographic questions).<br>The faculty will guide the student to prepare the PPT. | |

| | | | |
|---|---|---|---|
| | | The topic of the research should be related to social, economical or environmental issuesconcerning the common man.<br>The report should contain 2,500 to 3,000 words and relevant charts, tables andphotographs.<br>**Plagiarism check of the report must**.<br><br>ESE will conduct out of 100, divided in three parts (i) 30 Marks for report (ii) 30 Marksfor presentation (iii) 40 Marks for knowledge.<br><br>The student should **submit the report** to CCC-Coordinator signed by the faculty guide by<br>……<br>The students have to send the hard copy of the **report and PPT**, and then only they willbe allowed for ESE. | |
| 9.2 | **Role of CCC-Coordinator** | The CCC Coordinator will supervise the whole process and assign students to facultymembers. | |
| 9.3 | **Layout of theReport** | Abstract (250 words)<br><br>a. Introduction<br>b. Literature review(optional)<br>c. Objective of the research<br>d. Research Methodology<br>e. Finding and discussion<br>f. Conclusion and recommendation<br>g. References<br><br>Note: Research report should base on primary data. | |
| 9.4 | **Layout of theReport** | Abstract (250 words)<br>h. Introduction<br>i. Literature review(optional)<br>j. Objective of the research<br>k. Research Methodology<br>l. Finding and discussion<br>m. Conclusion and recommendation<br>n. References<br>Note: Research report should base on primary data. | |
| 9.5 | **Guideline for Report Writing** | **Title Page: The following elements must be included:**<br>• Title of the article;<br>• Name(s) and initial(s) of author(s), preferably with first names spelled out;<br>• Affiliation(s) of author(s);<br>• Name of the faculty guide and Co-guide<br>**Abstract:** Each article is to be preceded by a succinct abstract, of up to 250 words, thathighlights the objectives, methods, results, and conclusions of the paper. | |

| | | | |
|---|---|---|---|
| | | **Text: Manuscripts should be submitted in Word.**<br>• Use a normal, plain font (e.g., 12-point Times Roman) for text.<br>• Use italics for emphasis.<br>• *Use the automatic page numbering function to number the pages.*<br>• *Save your file in docx format* (Word 2007 or higher) or doc format (older Wordversions)<br>**Reference list:**<br>The list of references should only include works that are cited in the text and that havebeen published or accepted for publication.<br>The entries in the list should be in alphabetical order.Journal article | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| **CO2** | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| **CO4** | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| **CO5** | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 2 |
| **CO6** | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 |
| **Avg** | 1.5 | 2.0 | 1.5 | 1.8 | 1.2 | 1.0 | 1.7 | 1.8 | 1.8 | 1.2 | 2.3 | 1.7 | 1.7 |

**1. Slight (Low)** **2. Moderate (Medium)** **3. Substantial (High)**

# SEMESTER VII
# (Bachelor of Science (Honours) in Biotechnology)

**Course code: BBI403** **Course Title: Proteomics**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VII** | |
| **1** | Course Code | **BBI403** | |
| **2** | Course Title | Proteomics | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | DSE | |
| **5** | Course Objective | 1. Enhancing the basic understanding of the emerging technologies related to the analysis of genomes and proteomes<br>2. Imparting experimental design thinking capability in relation to using appropriate analytical methodologies for the qualitative and quantitative proteomics<br>3. Extrapolating the design thinking skills to real time scenarios, with special reference | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Explain the concepts of genomic and proteomic approaches<br>CO2: Apply the chromatographic and electrophoretic methodologies for the analysis of a given proteome<br>CO3: Analyse the utility of different analytical techniques that can be used to delineate the structural features of proteins<br>CO4: Evaluate the device methodologies for qualitative and qualitative analysis of the proteome with respect to posttranslational modification and molecular recognition events involving proteins<br>CO5: Apply proteomic approaches to analyse the disease conditions<br>CO6: Design and infer the basic concepts of genomics, transcriptomics and proteomics | |
| | Course Description | Students having a clear understanding of the proteomics related concepts and of contemporary issues. Students must be able to apply proteomic approaches to analyse the protein data. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction and overview of proteomics** | CO1,CO6 |
| | A | Overview of protein chemistry, revision on amino acids, peptide bond, primary, secondary, tertiary quaternary proteins | |
| | B | Functional proteomics in postgenomic era, Proteomics experimental workflows | |
| | C | Gene-Protein families link with examples, Human proteome draft | |
| | **Unit 2** | **Application of Chromatography in proteomics Structure** | CO2, CO6 |

| | | | |
|---|---|---|---|
| | A | Multidimensional chromatography, COFRADIC combined fractional diagonal chromatography | |
| | B | HILIC-hydrophilic interaction liquid chromatography, SAX- strong anion exchange chromatography, | |
| | C | SCX- strong cation-exchange chromatography, affinity chromatography, reverse phase and normal phase | |
| | **Unit 3** | **Abundance based Proteomics** | CO3, CO6 |
| | A | Gel based proteomics. Variations in 2-D gel electrophoresis, Difference Gel Electrophoresis (DIGE), and Mass spectrometry-based proteomics- Analysis of data | |
| | B | MALDI, SELDI, Peptide mass fingerprinting | |
| | C | Protein microarray (analytical, functional, reverse phase), protein sequencing | |
| | **Unit 4** | **Structural Proteomics and Post-translational modification Tagging of Proteins** | CO4, CO6 |
| | A | Application and principle: X-ray crystallography, Circular Dichroism, Nuclear Magnetic Resonance | |
| | B | Analysis of posttranslational modifications, Phosphorylation, ubiquitination (poly and mono), acetylation, nitration, glycosylation, disulphide bond formation. | |
| | C | Tagging of proteins with chemical and genetic approaches | |
| | **Unit 5** | **TargESEd Proteomics and applications** | CO5, CO6 |
| | A | Qualitative and quantitative proteome analysis, Short-gun proteomics for proteome profile, Expression proteome analysis (isotope-labeling and label-free approaches), | |
| | B | Proteomic analysis of protein-protein (including antigen-antibody interactions for epitope mapping), protein-DNA interactions | |
| | C | Proteomics in study of diseases, Proteomic analysis of body fluids, Western Blotting. | |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd ed. Benjamin Cummings 2007 | |
| | Other References | Voet D, Voet JG & Pratt CW, Fundamentals ofBiochemistry, 2nd ed. Wiley 2006 | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 3 |
| CO2 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 |
| CO3 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| CO4 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| CO5 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| CO6 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| Avg | 1.2 | 1.0 | 1.2 | 2.0 | 1.0 | 1.0 | 1.3 | 1.0 | 1.0 | 1.3 | 1.5 | 1.5 | 1.5 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

**Course code: BBT406** **Course Title: Cell signaling and cancer biology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VII** | |
| **1** | Course Code | **BBT406** | |
| **2** | Course Title | **Cell signaling and cancer biology** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | Understanding how intracellular signaling networks function in normal cells, and how they are altered in cancer cells. | |
| **6** | Course Outcomes | The student will be able to understand following purposes<br>CO1. Understand the basic principles of signal transduction mechanisms, in particular the concepts of response specificity, signal amplitude and duration, signal integration and intracellular location<br>CO2. Apply the knowledge of signalling pathway in the cell and understand the cell receptors and signal transduction.<br>CO3. Analyse the signalling pathways That Control Gene Expression<br>CO4. Evaluate and understand the role of cell signalling pathways in cancer.<br>CO5. Apply the molecular level of understanding of cell signalling in cancer biology<br>CO6. Understand and apply the knowledge of cell signalling in the cancer biology | |
| | Course description | It focuses on the mechanisms that underlie fundamental processes such as **cell** growth, the transformation of normal **cells** to **cancer cells**, and the spread (metastasis) of cancer cells. How the disturbance in cell signaling results in initiation and progression of cancer in the body. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Cell signaling** | CO1,CO6 |
| | A | **Signal Transduction and G Protein– Coupled Receptors-** Signaling Molecules Can Act Locally or at a Distance. Receptors Bind Only a Single Type of Hormone or a Group of Closely Related Hormones | |
| | B | Protein Kinases and Phosphatases Are Employed in Many Signaling Pathways. GTP-Binding Proteins Are Frequently Used in Signal Transduction Pathways as on/Off Switches. | |
| | C | Intracellular “Second Messengers” Transmit Signals from Many Receptors Signal Transduction Pathways Can Amplify the Effects of Extracellular Signals | |
| | **Unit 2** | **Studying Cell-Surface Receptors and Signal Transduction Proteins**. | CO2, CO6 |
| | A | G Protein–Coupled Receptors: Structure and Mechanism. | |

| | | | |
|---|---|---|---|
| | | Protein–Coupled Receptors That Regulate Ion Channels. | |
| | B | G Protein–Coupled Receptors That Activate or Inhibit Adenylyl Cyclase | |
| | C | G Protein–Coupled Receptors That Trigger Elevations in Cytosolic and Mitochondrial Calcium | |
| | **Unit 3** | **Signaling Pathways That Control Gene Expression.** | CO3, CO6 |
| | A | Receptor Serine Kinases That Activate Smads<br>Cytokine Receptors and the JAK/STAT Signaling Pathway<br>Receptor Tyrosine Kinases | |
| | B | The Ras/MAP Kinase Pathway; Phosphoinositide Signaling Pathways | |
| | C | Signaling Pathways Controlled by Ubiquitinoylation and Protein Degradation: Wnt, Hedgehog, and NF-κB | |
| | **Unit 4** | **Cancer- Fundamentals of cancer biology** | CO4, CO6 |
| | A | Introduction to Cancer Biology; Modulation of cell cycle in cancer Different forms of cancers, | |
| | B | Cancer screening and early Detection, action using biochemical assays tumor markers molecular tools for early diagnosis of cancer | |
| | C | **Principles of carcinogenesis** Theory of Carcinogenesis, Chemical carcinogenesis; Principles of physical carcinogenesis, Mechanisms of radiation carcinogenesis, Nutrition and cancer | |
| | **Unit 5** | **Principles of molecular cell biology of cancer** | CO5, CO6 |
| | A | Signal targets and cancer Activation of kinases Proto oncogenes and oncogenes activity Identification of oncogenes | |
| | B | Retroviruses and oncogenes, Detection of oncogenes, Growth factors related to transformation | |
| | C | Telomerases Tumour suppressor genes Single Nucleotide; Polymorphism (SNP) in cancer Molecular tools for identifying cancer genes | |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25 % | 75% |
| | Text book/s* | Becker JM, Cold Well GA & Zachgo EA. 2007. Biotechnology a Laboratory Course. Academic Press. | |
| | Other References | Brown CM, Campbell I & Priest FG. 2005. Introduction to Biotechnology. Panima. Singh BD. 2006. Biotechnology Expanding Horizon. Kalyani. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | - | - | 2 | - | 2 | 1 | 1 | 2 | 1 |
| CO2 | 3 | 1 | 1 | 2 | - | - | 2 | - | 2 | 1 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 1 | 2 | - | - | 3 | - | 3 | 2 | 2 | 3 | 1 |
| CO4 | 3 | 1 | 1 | 2 | - | - | 3 | - | 3 | 2 | 2 | 3 | 2 |
| CO5 | 3 | 1 | 1 | 2 | - | - | 3 | - | 3 | 2 | 2 | 3 | 2 |
| CO6 | 3 | 1 | 1 | 2 | - | - | 2 | - | 3 | 2 | 2 | 3 | 2 |
| Avg | 3.0 | 1.2 | 1.0 | 1.8 | - | - | 2.5 | - | 2.7 | 1.7 | 1.8 | 2.7 | 1.5 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year:2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VII** | |
| **1** | Course Code | **BBI401** | |
| **2** | Course Title | Biostatistics, Bioethics and IPR | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | To understand the concepts of statistics and able to utilize it on the experimental biological data. | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Understand the basic concepts of Statistics<br>CO2: Apply the concept of probability and its application<br>CO3: Analyze the correlation and regression using appropriate data<br>CO4: Evaluate and apply the concepts of IPR<br>CO5: To understand the bioethics in biology<br>CO6: Create and evaluate the biostatistics data for biological application | |
| | Course description: | Indepth understanding of statistics as well as to know the basics of bioethics and IPR. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Biostatistics** | CO1,CO6 |
| | A | Introduction to Biostatistics | |
| | B | Frequency distribution: Measures of central tendency: Mean, Median, Mode, standard deviation. | |
| | C | Measures of dispersion: Skewness & Kurtosis | |
| | **Unit 2** | **Probability and Correlation** | CO2, CO6 |
| | A | Probability: definition of probability and binomial distribution (numerical) | |
| | B | Sample, Population, large sample, small sample. Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, difference | |
| | C | Correlation: Definition, Karl Pearson's coefficient of correlation, Simple Regression, | |
| | **Unit 3** | **Hypothesis and Error** | CO3, CO6 |
| | A | Concept of Test of Hypothesis. Applications of t-test statistics to biological problems/data | |

| | | | |
|---|---|---|---|
| | B | Chi square, statistic applications in Biology | |
| | C | Error-I type, Error-II type, Standard error of mean | |
| | **Unit 4** | **IPR** | CO4, CO6 |
| | A | The concept of intellectual property, Importance of IPR in biotechnology, Indian laws and treaties for IPR | |
| | B | Patents-basic concepts, Infringement, compulsory licenses, Exploitation of the Patented Invention, Compulsory Licenses | |
| | C | Copyright and related rights; piracy and infringement and their remedies Definitions, Signs which serve as trademarks | |
| | **Unit 5** | **Bioethics** | CO5, CO6 |
| | A | Introduction to Biosafety, Need for Biosafety in present scenario | |
| | B | Classification and Description of Biosafety Levels, Design of Clean rooms, Design of Biosafety Labs, Biosafety Regulations. | |
| | C | Laws and Policies, Biosafety and Agriculture**,** Genetic Engineering and Health; Genetic Engineering and Food Safety. | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Fundamental of Statistics by S.C. Gupta, Himalaya Publishing House | |
| | Other References | •Pharmaceutical Statistics- Practical and Clinical Applications by Sanford Bolton, Marcel Dekker Inc. New York.<br>•Design and Analysis of Experiments by R. Pannerselvam, PHI Learning Private Limited.<br>•Design and Analysis of Experiments by Douglas and C. Montgomery, Wiley Students Edition. | |

**CO-PO-PSO Mapping**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 |
| **CO2** | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO3** | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 |
| **CO6** | 1 | 3 | 2 | 2 | - | - | 3 | 2 | 3 | 2 | 1 | 1 | 2 |
| **Avg** | 1.3 | 1.5 | 1.5 | 1.5 | 1.4 | 1.0 | 2.0 | 1.5 | 1.3 | 1.5 | 1.3 | 1.0 | 1.5 |

**1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)**

**Course code: BBI402** **Course Title: Introduction to Nanotoxicology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VII** | |
| **1** | Course Code | **BBI402** | |
| **2** | Course Title | **Introduction to Nanotoxicology** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | DSE | |
| **5** | Course Objective | The objective of Nano-toxicology is to understand the inorganic-based nanomaterials, carbon-based nanomaterials, organic-based nanomaterials; and composite-based nanomaterials. Students will be able to understand the effects of nano particulates on human system. | |
| **6** | Course Outcomes | The student at the completion of the course will be able to:<br>CO1: Understand the concepts of nanomaterials and toxicity.<br>CO2: To apply the knowledge of nanomaterials on human health<br>CO3: To analyze the toxicity of nanomaterials.<br>CO4: Evaluate the role of various factors and their effects on the level of nanotoxicity<br>CO5: Apply the knowledge of risk and reach analysis emphasizing the role of regulatory guidelines<br>CO6: Create the knowledge of toxicity with reference to nanomaterials prior to clinical use | |
| **7** | Course Description | Nanotoxicology is a new area of study that deals with the toxicological profiles of nanomaterials (NMs). Compared with the larger counterparts, the quantum size effects and large surface area to volume ratio brings NMs their unique properties that may or may not be toxic to living things | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Nanomaterials and Nanotoxicology** | CO1,CO6 |
| | A | Natural and synthetic nanomaterials, | |
| | B | Biological and Environmental applications of nanomaterials, | |
| | C | Study of nano-bio interface | |
| | **Unit 2** | **Nanotoxicity and human health** | CO2, CO6 |
| | A | Fate of nanomaterials in human body: short term and long-term effects | |
| | B | Acute and chronic toxicity, | |
| | C | Study of different levels toxicity based on organs | |
| | **Unit 3** | **Determination of nanotoxicity** | CO3, CO6 |
| | A | In vitro, in vivo, and ex vivo models to study the effects of nanomaterials on mammalian cells and tissues | |
| | B | Histological Analysis | |

| | | | |
|---|---|---|---|
| | C | hematological analysis, serum biochemical analysis | |
| | **Unit 4** | **Factors for determining nanotoxicity** | CO4, CO6 |
| | A | Size, shape, charge, aggregation, and interaction behavior of nanomaterials for determining the toxicity level, | |
| | B | Nanomaterials interactions with serum proteins, | |
| | C | protein-corona formation | |
| | **Unit 5** | **Regulatory guidelines for nanomaterials** | CO5, CO6 |
| | A | Risk assessment analysis, | |
| | B | Regulatory guidelines like ISO guidelines, | |
| | C | ASTM guidelines, CDSO and reach analysis | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA | ESE |
| | | 25% | 75% |
| | Text book/s* | Fundamentals of Nanotoxicology, Editor P.K. Gupta, Academic Press, 2022, ISBN 9780323903998 | |
| | Other References | Nanotoxicity: From In Vivo and In Vitro Models to Health Risks, Editor(s): Saura C. Sahu Daniel A.<br>Casciano 2- Nanotoxicity Methods and Protocols, Editors Joshua Reineke 3- Recent research articles | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 |
| **CO2** | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 1 | 1 | 1 |
| **CO3** | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO4** | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 |
| **CO5** | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 2 |
| **CO6** | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| **Avg** | 2.0 | 1.5 | 1.5 | 1.0 | 1.0 | 1.0 | 1.7 | 1.8 | 1.0 | 1.8 | 1.8 | 1.8 | 1.5 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

**Course code: FST413** **Course Title: Functional Food and Nutraceuticals**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-27** |
| **Branch: Biotechnology** | | **SEMESTER: VII** |
| **1** | Course Code | **FST413** |
| **2** | Course Title | **Functional Food and Nutraceuticals** |
| **3** | Credits | 4 |
| **4** | Contact Hours (L-T-P) | 4-0-0 |
| | Course Status | **DSE** |
| **5** | Course Objective | • To understand the interrelationship between nutraceuticals and health maintenance.<br>• Understanding the traditional system of medicine as well as the need for changing trends in the nutraceutical Functional Food Industry.<br>• To learn the efficacy and safety of nutraceutical and functional food products.<br>• 4. To learn the packaging and labelling strategies of remedial food. |
| **6** | Course Outcomes | After successful completion of this course students will be able to:<br><br>CO1: Recall the basic principles and concepts of functional food and nutraceuticals.<br>CO2: Describe and understand the properties, structure, and functions of nutraceuticals.<br>CO3: Apply the principles of formulation and development of functional food and nutraceutical products for specific health conditions or populations<br>CO4**:** Analyze about the different sources of functional food and nutraceuticals, there application and packaging and labelling requirements.<br>CO5: Assess the potential risks and benefits associated with the consumption of specific functional food and nutraceutical products and Safety regulations in USA, EU and India.<br>CO6: Understand the basic concepts of nutraceuticals and functional food and use those concepts to development of food products and Evaluate the impact of functional food and nutraceutical interventions on the overall health and well-being of individuals |
| **7** | Course Description | This course comprises of the structure, function, properties and significance of functional and nutraceutical food. Sources and health benefits will be studied in details. |
| **8** | **Outline syllabus** | **CO Mapping** |
| | **Unit 1** | **Introduction to Nutraceuticals and Functional Food** CO1,CO6 |
| | A | Definition, national and international status, scope & prospects of nutraceuticals and functional food. |
| | B | Applied aspects of the Nutraceutical and Functional Food Science. Sources of Nutraceuticals. Relation of functional foods & Nutraceutical to foods. |
| | C | Formulation considerations and challenges, new product development |
| | **Unit 2** | **Properties and Functions of Nutraceuticals and Functional Foods** CO2, CO6 |

| | | | |
|---|---|---|---|
| | A | Nutraceuticals: Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha-ketoglutarate, pro-anthocyanidins, grape products, flaxseed oil and others | |
| | B | Functional Foods: Sources and role of Isoprenoids, Isoflavones, Flavonoids, carotenoids, Tocotrienols, Polyunsaturated fatty acids, sphingolipids, lecithin, choline, Terpenoids | |
| | C | Vegetables, Cereals, milk and dairy products as Functional foods and others. | |
| | **Unit 3** | **Role of Functional Foods as Remedial Foods and Disease Prevention** | CO3, CO6 |
| | A | Nutraceuticals bridge the gap between food and drug. | |
| | B | Nutraceuticals – garlic, grape, wine, tea, soy proteins and soy isoflavones, dietary fibre, omega-3 fatty acids, antioxidants and phytochemicals, single-cell proteins, and marine-derived nutraceuticals. | |
| | C | Nutraceutical remedies for common disorders like circulatory problems, hypo-glycemia, nephrological disorders, liver disorders, osteoporosis, gastrointestinal disorders, and cardiovascular diseases. | |
| | **Unit 4** | **utraceutical Sources and Packaging & Labelling Requirements for Functional Food Products** | CO4, CO6 |
| | A | Plant secondary metabolites: Role of Plant Sterols and Phytoestrogens in Functional Foods, Phenolics in Herbal and Nutraceutical Products. | |
| | B | Animal metabolites: Fat-rich functional food and their applications - Functional Fats and Spreads, modified fats and oils. Functional Meat as Functional Foods, Functional Confectionery and other functional Products | |
| | C | Packaging and labelling requirements: Packaging and packaging materials, an overview of dietary supplements labelling, nutrition labelling requirements. | |
| | **Unit 5** | **Claims, Marketing and Regulations for Functional Food Products** | CO5, CO6 |
| | A | Nutritional content claims, health claims and exemption from FDA requirements, Dietary supplements labelling issues, regulatory agencies views on label claims. | |
| | B | The market for Functional Food Products: Market scenario, Functional foods and consumers. | |
| | C | The role of health in food choice; Functional foods market; Regulations and laws for functional food. Regulations in USA, EU and India | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | Internal (CA+MSE) | External (ESE) |
| | | **25%** | **75%** |
| | Text book/s* | 1. A. E. Bender, "Nutrition and Dietetic Foods", Chem. Pub. Co. New York, 2ndEdition, 2004.<br>2. P. S. Howe, "Basic Nutrition in Health and Disease",2ndEdition,W. B. Saunders Company, London, 2003.<br>3. Kramer, "Nutraceuticals in Health and Disease Prevention", Hoppe and Packer, Marcel Dekker, Inc., NY 2001. | |
| | Other References | 1. Bao and Fenwick, "Phytochemicals in Health and Disease", Marcel Decker, Inc. NY 2004.<br>2. Rotimi E.Aluko. Functional Foods and Nutraceuticals. Springer. | |

**CO-PO-PSO Mapping**

| CO/PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | - | - | 1 | 1 | - | 2 | - | - | - | - |
| **CO2** | 1 | 1 | 1 | - | - | 1 | 1 | - | 2 | - | - | - | - |
| **CO3** | 1 | 1 | 2 | - | - | 1 | 2 | - | 2 | - | - | - | - |
| **CO4** | 1 | 2 | 2 | - | - | 1 | 2 | - | 2 | - | - | - | - |
| **CO5** | 1 | 2 | 2 | - | - | 1 | 3 | - | 2 | - | - | - | - |
| **CO6** | 1 | 2 | 2 | - | - | 2 | 3 | - | 2 | - | - | - | - |
| **Avg** | 1.0 | 1.5 | 1.7 | - | - | 1.2 | 2.0 | - | 2.0 | - | - | - | - |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

| | | | | |
|---|---|---|---|---|
| **School: SSBSR** | | **Batch:**2023-27 | | |
| **Programme: B.Sc (Hons.)** | | **Current Academic Year:2023-24** | | |
| **Branch: Biotechnology** | | | | |
| **1** | **Course Code** | **CHE101** | | |
| **2** | **Course Title** | **Fundamentals of Chemistry** | | |
| **3** | **Credits** | 4 | | |
| **4** | **Contact Hours (L-T-P)** | 4-0-0 | | |
| **5** | **Course Type** | Minor | | Theory |
| **6** | **Course Objective** | Students will gain an understanding of:<br>1. Molecular polarity and weak chemical forces.<br>2. Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters.<br>3. Periodic properties of elements.<br>4. The basics of organic chemistry give the most primary and utmost important knowledge and concepts of organic Chemistry, theoretical picture in multiple stages in an overall chemical reaction.<br>5. Reactive intermediates, transition states and states of all the bonds broken and formed, reaction mechanism.<br>6. Stereochemistry of simple organic molecules. | | |
| **7** | **Course Outcomes** | The student will be able to<br>CO1: explain molecular polarity and weak chemical forces<br>CO2: describe simple bonding theories of molecules.<br>CO3: discuss periodic properties of elements and recapitulate basics of Organic Chemistry<br>CO4: explain mechanism of organic reactions.<br>CO5: illustrate stereochemistry of simple organic molecules.<br>CO6: apply the knowledge to solve simple scientific problems. | | |
| **8** | **Course Description** | This course includes introduction to Indian ancient Chemistry and the contribution of Indian Chemists, describes molecular polarity, weak chemical forces, chemical bonding, periodic properties of elements, organic reaction intermediate, reaction mechanism, stereochemistry. | | |
| **9** | **Outline Syllabus** | | | CO Mapping |
| | **Unit 1** | | | |
| | **A** | Introduction to Indian Ancient Chemistry and contribution of Indian Chemists.<br>**Molecular Polarity and Weak Chemical Forces**<br>Formal charge, Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment. | | CO1 |

| | | | |
|---|---|---|---|
| | **B** | Polarizing power and polarizability. Fajan's rules and consequenceof polarization. Hydrogen bonding. | CO1, CO6 |
| | **C** | Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process. Lattice energy and Born-Haber cycle, solvation energy, and solubility of ionic solids. | CO1, CO6 |
| | **Unit 2** | **Simple Bonding theories of Molecules** | |
| | **A** | Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach), valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry. | CO2, CO6 |
| | **B** | Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: $H_2O$, $NH_3$, $PCl_5$, $SF_6$, $SF_4$, $ClF_3$, $I_3^-$, $ClF_2^{--}$. | CO2, CO6 |
| | **C** | Molecular orbital theory (MOT). Molecular orbital diagrams, bond orders of homonuclear and heteronuclear diatomic molecules and ions ($N_2$, $O_2$, $C_2$, $B_2$, $F_2$, CO, NO, and their ions). | CO2, CO6 |
| | **Unit 3** | **Basics properties of elements and introduction to Organic chemistry** | |
| | **A** | **Periodic Properties of Elements**<br>Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy. | CO3, CO6 |
| | **B** | **Recapitulation of Basics of Organic Chemistry**<br>Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Van der Waals interactions, inclusion compounds, Clathrates, Charge transfer complexes, hyperconjugation, Dipole moment | CO3, CO6 |
| | **C** | Electronic Displacements: Inductive, electromeric, resonance, mesomeric effects and their applications | CO3 , CO6 |
| | **Unit 4** | **Mechanism of Organic Reactions** | |
| | **A** | Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles. | CO4 |
| | **B** | Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). | CO4, CO6 |
| | **C** | Types of organic reactions, Energy considerations. | CO4, CO6 |
| | **Unit 5** | **Concept of isomerism** | |
| | **A** | Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation. | CO5, CO6 |
| | **B** | Relative and absolute configuration, sequence rules, D & L and R & | CO5, |

| | | | |
|---|---|---|---|
| | | S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. | CO6 |
| | **C** | Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds | CO5, CO6 |
| | **Mode of examination** | Theory | |
| | **Weightage Distribution** | CA | ETE |
| | | 25% | 75% |
| | **Text Book/s *** | 1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010.<br>2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).<br>3. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc. | |
| | **Other References** | 1. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970.<br>2. Carey, F. A., Guiliano, R. M.Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.<br>3. Clayden, J., Greeves, N. &Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.<br>4. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO2** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO3** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO4** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO5** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO6** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **Avg** | 1.0 | 1.0 | - | - | - | - | - | - | 2.0 | - | - | - | - |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

**Course code: BBI404** **Course Title: Introduction to Nanotoxicology Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-2027** |
| **Branch: Biotechnology** | | **SEMESTER: VII** |
| **1** | Course Code | **BBI404** |
| **2** | Course Title | **Introduction to Nanotoxicology Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | DSE |
| **5** | Course Objective | The objective of Nano-toxicology is to understand the inorganic-based nanomaterials, carbon-based nanomaterials, organic-based nanomaterials; and composite-based nanomaterials. Students will be able to understand the effects of nano particulates on human system. |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>**CO1:** To studying the development of various nanomaterials<br>**CO2:** To examine the physicochemical properties of nanomaterials<br>**CO3:** To determine the nanotoxicity on in vitro models<br>**CO4:** Determining the nano-bio interface at protein levels<br>**CO5:** To analyze the nanomaterial toxicity using bioinformatics approaches<br>**CO6:** Overall studying the physicochemical parameters of nanomaterials and emphasizing their role on nanotoxicity |
| **7** | Course Description | Nanotoxicology is a new area of study that deals with the toxicological profiles of nanomaterials (NMs). Compared with the larger counterparts, the quantum size effects and large surface area to volume ratio brings NMs their unique properties that may or may not be toxic to living things |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Development of nanomaterials** | |
| | A | Introduction to Nanotoxicology Lab; GLP | CO1, CO6 |
| | B | Fabrication of organic (polymer) nanomaterials via different methodological approaches | CO1,CO6 |
| | C | Fabrication of inorganic (metal/metal oxide) nanomaterials via different methodological approaches | CO1,CO6 |
| | **Unit 2** | **Physicochemical characterization analysis** | |
| | A | Determining the surface plasmon resonance property | CO2, CO6 |
| | B | Determining the magnetization, size, shape, crystanillity. | CO2, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | C | Determining the particle composition and thermal analysis | | | CO2, CO6 |
| | **Unit 3** | **Determination of nanotoxicity on in vitro models** | | | |
| | A | Introduction to nanomaterial Toxicity | | | CO3, CO6 |
| | B | Studying the nanomaterial toxicity on mouse fibroblast cells (MTT test) | | | CO3, CO6 |
| | C | Studying the hemocompatibility of nanomaterial | | | |
| | **Unit 4** | **Toxic effects of nanomaterials on serum proteins** | | | |
| | A | Nanoparticle-protein interaction study | | | CO4, CO6 |
| | B | Nanoparticle-protein degradation and conformational change analysis | | | CO4, CO6 |
| | C | Nanoparticle-protein protein-corona analysis | | | CO4, CO6 |
| | **Unit 5** | **Bioinformatic analysis of nanomaterial toxicity** | | | |
| | A | Determining the effects of nanomaterials on various structural and functional proteins. | | | CO5, CO6 |
| | B | Effects of nanomaterials on DNA damage | | | CO5, CO6 |
| | C | Oxidative stress analysis | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks Viva-Voce (on the basis of weekly Viva performance): 25 Marks ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | Nanotoxicity: From In Vivo and In Vitro Models to Health Risks, Editor(s): Saura C. Sahu Daniel A. Casciano | | | |
| | Reference books | 2- Nanotoxicity Methods and Protocols, Editors Joshua Reineke<br>3- Recent research articles | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 |
| **CO2** | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 1 | 1 | 1 |
| **CO3** | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO4** | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 |
| **CO5** | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 2 |
| **CO6** | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| **Avg** | 2.0 | 1.5 | 1.5 | 1.0 | 1.0 | 1.0 | 1.7 | 1.8 | 1.0 | 1.8 | 1.8 | 1.8 | 1.5 |

***1.Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

**Course code: BBI405** **Course Title: Proteomics Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-2027** |
| **Branch: Biotechnology** | | **SEMESTER: VII** |
| **1** | Course Code | **BBI405** |
| **2** | Course Title | **Proteomics Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | DSE |
| **5** | Course Objective | To Express protein and purify it.<br>To determine and characterization of enzyme kinetics |
| **6** | Course Outcomes | The student at the completion of the course will be able to:<br>**CO1:** Understand the role of protein in bacterial system<br>**CO2:** Analyze the amount of the protein in the media<br>**CO3:** Understand the purification process of the protein<br>**CO4:** Apply the knowledge of analytical techniques in determining protein activity<br>**CO5:** To analyze the protein sequences using bioinformatics approaches<br>**CO6:** Evaluate the protein expression mechanism using bioinformatics tools |
| **7** | Course Description | Protein is the building block of functional unit in Human metabolic activities. They will learn to express the heterologous protein in the bacterial system subsequently purify it and able to characterize it |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Introduction to proteomics Lab** | |
| | A | Good Lab practices | CO1, CO6 |
| | B | Buffers preparation | CO1,CO6 |
| | C | Sterilization of glassware etc | CO1,CO6 |
| | **Unit 2** | **Expression of protein** | |
| | A | Preparation of media and growth of cloned bacteria | CO2, CO6 |
| | B | Expression of heterologous protein in bacterial system | CO2, CO6 |
| | C | Detection of expressed protein | CO2, CO6 |

| | | | | | |
|---|---|---|---|---|---|
| | **Unit 3** | **Downstream Processing** | | | |
| | A | Purification of recombinant protein. | | | CO3, CO6 |
| | B | Ion exchange Chromatography | | | CO3, CO6 |
| | C | Gel filtration chromatography | | | |
| | **Unit 4** | **Characterization of protein** | | | |
| | A | PAGE- gel electrophoresis | | | CO4, CO6 |
| | B | Quantification of protein | | | CO4, CO6 |
| | C | Characterization of purified protein using enzymatic activity | | | CO4, CO6 |
| | **Unit 5** | **PDB databases** | | | |
| | A | Browsing through PDB databases, | | | CO5, CO6 |
| | B | retrieving and working with protein data. | | | CO5, CO6 |
| | C | KEGG proteins and intergenic regions | | | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | | | | |
| | Reference books | | | | |

**CO-PO-PSO Mapping**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| **CO2** | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 |
| **CO3** | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 2 | 1 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 |
| **CO6** | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 |
| **Avg** | 1.8 | 1.7 | 1.2 | 2.3 | 1.0 | 1.0 | 2.0 | 1.5 | 1.0 | 1.5 | 1.7 | 1.7 | 1.5 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

# SEMESTER VIII
# Bachelor (Honours) in Biotechnology

**Course code: BBI411** **Course Title: Functional Genomics**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VIII** | |
| **1** | Course Code | **BBI411** | |
| **2** | Course Title | **Functional Genomics** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1. To comprehend the basic principles of genomics, so that they realize its importance and use its knowledge for human benefit.<br>2. To acquire knowledge of techniques and strategies involved in understanding a genome. | |
| **6** | Course Outcomes | The student will be able to:<br>CO1: Understand the basic concept of Genomics and its importance.<br>CO2: Evaluate the correct and appropriate sequencing method.<br>CO3: Differentiate between different sequencing methods and the degree of enhancement in techniques with application of bioinformatics.<br>CO4: Analyse the differences between various Genome structure.<br>CO5: Apply the techniques of locating unidentified genes in a sequence and their organization.<br>CO6: Develop the application of Genomics in different field of study | |
| **7** | Course Description | Genomics is an interdisciplinary field of science focusing on the structure, function, evolution, mapping, and editing of genomes. Genomics also involves the sequencing and analysis of genomes through uses of high throughput DNA sequencing and bioinformatics to assemble and analyse the function and structure of entire genomes. Advances in genomics have triggered a revolution in discovery-based research and systems biology to facilitate understanding of even the most complex biological systems such as the brain | |
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **DNA Sequencing** | CO1,CO6 |
| | A | Introduction to concept of Genome; DNA and RNA as genome | |
| | B | Information flow in Biology; DNA Sequencing technologies, Maxam- Gilbert | |
| | C | Sanger method of Sequencing, manual and automated | |
| | **Unit 2** | **Whole Genome Sequencing** | CO2, CO6 |
| | A | Concept and application of Whole genome sequencing, Shot Gun Sequencing methods | |

| | | | |
|---|---|---|---|
| | B | Clone contig Sequencing methods; Pyrosequencing | |
| | C | Genome sequence data and genome databases; Application of Bioinformatics in genomics | |
| | **Unit 3** | **Genome Anatomy** | CO3, CO6 |
| | A | Difference between gene and genome; Prokaryotic and eukaryotic genome structure | |
| | B | Intergenic spaces, gene families, monopartite genome, multipartite genome, split genes, overlapping genes. | |
| | C | C value Paradox, viral genome, Yeast and Drosophila genome structure | |
| | **Unit 4** | **Functional genomics** | CO4, CO6 |
| | A | Gene prediction methods, function prediction, Annotation, Functional, genomics, its tools and methodologies, | |
| | B | Organellar genomes, endosymbiosis | |
| | C | Comparative genomics its tools and methodologies, phylogeny | |
| | **Unit 5** | **Application of Genomics** | CO5, CO6 |
| | A | Application of comparative genomics, Pharmaco-genomics | |
| | B | Application of genomics in crop improvement | |
| | C | Application of genomics in industry; personalized medicine | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25 % | 75% |
| | Text book/s* | Pevsner J., "Bioinformatics and Functional Genomics", John Wiley and Sons, 2008 | |
| | Other References | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | - | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 1 | - | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 |
| **CO3** | 2 | 1 | 2 | - | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| **CO4** | 2 | 2 | 2 | - | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 2 | 1 | - | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 |
| **CO6** | 2 | 1 | 2 | - | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 |
| **Avg** | 2.0 | 1.5 | 1.7 | - | 1.0 | 1.0 | 1.8 | 1.5 | 1.0 | 1.3 | 1.5 | 1.5 | 1.5 |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VIII** | |
| **1** | Course Code | **BBI412** | |
| **2** | Course Title | **Applications of Industrial Biotechnology** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1. To introduce the students with industrial biotechnology and its application.<br>2. To develop the knowledge and techniques of production of compounds at industrial level.<br>3. To enable students about process economics and developing cost effective processes.<br>4. To create awareness about fermentation and industrial application microbes. | |
| **6** | Course Outcomes | After successfully completion of this course students will be able to:<br>CO1: Understand the basics concepts of industrial biotechnology and unit operations used in biotech industries.<br>CO2: Apply the microbes for the production of industrially important enzymes.<br>CO3: Evaluate the sustainable processing for bio-based products.<br>CO4: Apply the knowledge of biosensors and commercial biosensors.<br>CO5: Develop new approaches to pollution prevention, resource conservation, and cost reduction during bioprocessing.<br>CO6: Evaluate and develop industrial biotechnology processes including its application | |
| **7** | Course Description | Industrial biotechnology includes modern application of biotechnology for sustainable processing and production of chemical products, materials and fuels. Biotechnological processing uses enzymes and microorganisms to produce products that are useful to a broad range of industrial sectors, including chemical and pharmaceutical, human and animal nutrition, pulp and paper, textiles, energy, materials and polymers, using renewable raw materials. | |
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Industrial Biotechnology** | CO1,CO6 |
| | A | Units and dimensions | |
| | B | Unit operations involved in Industrial Biotechnology | |
| | C | Products and market economics relating to industrial biotechnology | |
| | **Unit 2** | **Production of commercially important enzymes** | CO2, CO6 |
| | A | Celluloses, Amylase, Lipase, Proteases, Lysozyme | |
| | B | Enzymes for the food, pharmaceutical and detergent Industries | |
| | C | Biotechnological advances in enzyme production | |
| | **Unit 3** | **Biotransformation and fermentation** | CO3, CO6 |

| | | | |
|---|---|---|---|
| | A | Transformation – steroids, alkaloids, and polysaccharides, Recent advances in biotransformation (Indigo, Xanthan, Malanins) | |
| | B | Natural bio-preservatives (nisin) Selected foods of commercial importance from plants and animal sources. | |
| | C | Process involved in preparation of Yoghurt, acidophilus milk, cheese, bread, alcoholic beverage, vinegar | |
| | **Unit 4** | **Biosensors** | CO4, CO6 |
| | A | Types of Biosensors | |
| | B | Biomedical Sensors | |
| | C | Commercial examples of Biosensors | |
| | **Unit 5** | **Industrial Bio-waste management** | CO5, CO6 |
| | A | Types of industrial waste Techniques of waste treatment | |
| | B | Value addition to industrial waste Production of bioplastics (PHB, PHA), | |
| | C | Bioinsecticides, bioherbicides, biopolymers, Biofertilizers and biological weapons with reference to anthrax | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Michael L. Shuler and Fikret Kargi (2009, Second edition) Bioprocess Engineering-Basic concepts. Pearson Prentice Hall | |
| | Other References | Pauline M. Doran (2010) Bioprocess Engg. Principles. Elsevier, California.<br>B. D. Singh (2009, Revised edition) Biotechnology- Expanding Horizons. Kalyani publishers, Ludhiana-141008 | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | - | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 |
| **CO3** | 3 | 2 | 2 | - | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 1 |
| **CO4** | 2 | 2 | 2 | - | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 3 | 2 | 2 | - | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 1 |
| **CO6** | 2 | 2 | 2 | - | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 |
| **Avg** | 2.5 | 2.0 | 2.0 | - | 1.3 | 2.0 | 2.0 | 2.0 | 1.0 | 1.7 | 2.0 | 1.5 | 1.3 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VIII** | |
| **1** | Course Code | **BBI414** | |
| **2** | Course Title | **Fundamental Bioinformatics** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | DSE | |
| **5** | Course Objective | To teach the basic concept of Bioinformatics, databases and sequence analysis<br>To develop understanding of sequence analysis<br>To provide knowledge of scoring matrix and Detection of functional sites etc.<br>To impart knowledge related to phylogenetic analysis protein structure prediction | |
| **6** | Course Outcomes | After successfully completion of this course students will be able to:<br>CO1: Understand concepts and application of Bioinformatics, types of databases, sequence similarity,sequence patterns and profiles<br>CO2: Apply the sequence alignment techniques, database searching, pairwise and multiple sequence<br>alignment using various tools.<br>CO3: Develop scoring matrices and its types including PAM , BLOSUM series and matrices fornucleic acid and protein sequences<br>CO4: Apply phylogeny and its concepts in molecular evolution and different methods of Phylogenetic tree construction<br>CO5: To create the protein structure using sequences prediction and knowledge of bioinformatics in drug designing<br>CO6:.To evaluate the structure of proteins using computational approach | |
| | Course Description | Industrial biotechnology includes modern application of biotechnology for sustainable processing and production of chemical products, materials and fuels. Biotechnological processing uses enzymes and microorganisms to produce products that are useful to a broad range of industrial sectors, including chemical and pharmaceutical, human and animal nutrition, pulp and paper, textiles, energy, materials and polymers, using renewable raw materials. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Bioinformatics** | CO1,CO6 |
| | A | Biological databases: Nucleotide databases, Protein databases, Specialized databases | |
| | B | Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, FASTA etc.; | |
| | C | Basic concepts of sequence similarity: identity and homology. | |

| | | | |
|---|---|---|---|
| | **Unit 2** | **Tools for sequence alignment** | CO2, CO6 |
| | A | Sequence Alignment and Database Searching: Introduction, Evolutionary Basis of Sequence Alignment, Optimal alignment method | |
| | B | Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment | |
| | C | Tools for multiple sequence alignment. | |
| | **Unit 3** | **Scoring matrix** | CO3, CO6 |
| | A | Scoring Matrices: Basic concept of a scoring matrix | |
| | B | Similarity and distance matrix, Substitution matrices | |
| | C | Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series | |
| | **Unit 4** | **Phylogenetics** | CO4, CO6 |
| | A | Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny | |
| | B | definition and description of Phylogenetic trees and various types of trees | |
| | C | Different methods of Phylogenetic tree construction | |
| | **Unit 5** | **Protein identification** | CO5, CO6 |
| | A | Protein identification based on composition, Physical properties based on sequence, Motif and pattern | |
| | B | Secondary structure (Statistical method: Chou Fasman and GOR method | |
| | C | Tertiary structures **(**Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.); Application of bioinformatics in drug discovery and drug designing. | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | D.W.Mount; Bioinformatics-Sequence and genome analysis; Cold Spring HarbourLab press. 2001 | |
| | Other References | B.N.Mishra; Bioinformatics: Concept and application, Pearson Education 2020<br>O' Reilly; Developing Bioinformatics computer skills-1stIndian edition, SPD publication.2001<br>Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1stEd 1976<br>Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press 2001 | |

**CO-PO-PSO Mapping**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 |
| **CO3** | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| **CO4** | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 |
| **CO6** | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 |
| **Avg** | 2.0 | 1.7 | 1.7 | 3.0 | 1.0 | 1.0 | 1.8 | 1.5 | 1.0 | 2.0 | 1.5 | 1.5 | 1.5 |

***1. Slight (Low)  2. Moderate (Medium)  3. Substantial (High)***

**Course code: BBI415** **Course Title: Fundamental Bioinformatics Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc. (Hons.)** | | **Current Academic Year: 2026-2027** |
| **Branch: Biotechnology** | | **SEMESTER: VIII** |
| **1** | Course Code | **BBI415** |
| **2** | Course Title | **Fundamental Bioinformatics Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | DSE |
| **5** | Course Objective | • To retrieval of the sequence data<br>• Demonstration of locating the chromosome and retrieval of gene expression data<br>• To provide practical knowledge for retrieval of PubMed data.<br>• Practical knowledge of ORF finding, motif information and retrieval of Gene information |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Practical knowledge of retrieving data<br>CO2: Locating the chromosome of a gene<br>CO3: Finding ORF of a given sequence.<br>CO4: Retrieving motif information of a protein<br>CO5: Retrieving Gene Information |
| **7** | Course Description | Students should be able to demonstrate the retrieval of sequence data and **p**erform experiments related to locating chromosome and gene expression data. They will be able to learn different tools of PubMed. Also, able to perform the ORF finding and retrieval of gene information |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Introduction to basic tools of Bioinformatics** | |
| | A | Retrieving sequence data from Entrez | CO1, CO6 |
| | B | Retrieve gene expression data from GEO | CO1,CO6 |
| | C | Retrieving articles using PubMed | CO1,CO6 |
| | **Unit 2** | **Sequence Alignment** | |
| | A | BLAST; Types of BLAST | CO2, CO6 |

| | | | |
|---|---|---|---|
| | B | Multiple Sequence alignment | CO2, CO6 |
| | C | Construct Phylogenetic tree | CO2, CO6 |
| | **Unit 3** | **Prediction tools-1** | |
| | A | Locating the chromosome of a Gene | CO3, CO6 |
| | B | Finding ORF of a Given Sequence | CO3, CO6 |
| | C | Prediction of secondary structure of RNA using any web server. | CO3, CO6 |
| | **Unit 4** | **Protein Databases** | |
| | A | Introduction to protein databases | CO4, CO6 |
| | B | Retrieving structural data of a protein using PDB database | CO4, CO6 |
| | C | Retrieving Motif Information of a Protein Using Prosite | CO4, CO6 |
| | **Unit 5** | **Prediction tools -2** | |
| | A | Retrieving Gene Information from TAIR database | CO5, CO6 |
| | B | Construction and analysis of Ramachandran Plot using any suitable web server | CO5, CO6 |
| | C | Comparative assessment of best available tools for genome annotation | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | |
| | Weightage Distribution | CA / CE / ESE | |
| | | 25% / 25% / 50% | |
| | Text books | P. F. Stanbury, S. J. Hall and A. Whitaker, Principles of Fermentation Technology, IInd Edn.,Elsevier, Science & Technology Books, 2005.<br>B. D. Singh (2009, Revised edition) Biotechnology- Expanding Horizons. Kalyani publishers, Ludhiana-141008 | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | **3** | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 1 | 1 | **3** | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO3** | 2 | 1 | 1 | **3** | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| **CO4** | 2 | 1 | 1 | **3** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 1 | 1 | **3** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO6** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **Avg** | 1.8 | 1.0 | 1.2 | 3.0 | 1.0 | 1.0 | 1.5 | 1.0 | 1.0 | 1.7 | 1.5 | 1.5 | 1.5 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

# SEMESTER VII
# Bachelor (Honours with Research) in Biotechnology

**Course code: BBT406** **Course Title: Cell signaling and cancer biology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons. With Research)** | | **Current Academic Year: 2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VII** | |
| **1** | Course Code | **BBT406** | |
| **2** | Course Title | **Cell signaling and cancer biology** | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | Understanding how intracellular signaling networks function in normal cells, and how they are altered in cancer cells. | |
| **6** | Course Outcomes | The student will be able to understand following purposes<br>CO1. Understand the basic principles of signal transduction mechanisms, in particular the concepts of response specificity, signal amplitude and duration, signal integration and intracellular location<br>CO2. Apply the knowledge of signalling pathway in the cell and understand the cell receptors and signal transduction.<br>CO3. Analyse the signalling pathways That Control Gene Expression<br>CO4. Evaluate and understand the role of cell signalling pathways in cancer.<br>CO5. Apply the molecular level of understanding of cell signalling in cancer biology<br>CO6. Understand and apply the knowledge of cell signalling in the cancer biology | |
| | Course description | It focuses on the mechanisms that underlie fundamental processes such as **cell** growth, the transformation of normal **cells** to **cancer cells**, and the spread (metastasis) of cancer cells. How the disturbance in cell signaling results in initiation and progression of cancer in the body. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Cell signaling** | CO1,CO6 |
| | A | **Signal Transduction and G Protein– Coupled Receptors-** Signaling Molecules Can Act Locally or at a Distance.<br>Receptors Bind Only a Single Type of Hormone or a Group of Closely Related Hormones | |
| | B | Protein Kinases and Phosphatases Are Employed in Many Signaling Pathways.<br>GTP-Binding Proteins Are Frequently Used in Signal Transduction Pathways as on/Off Switches. | |

| | | | |
|---|---|---|---|
| | C | Intracellular “Second Messengers” Transmit Signals from Many Receptors Signal Transduction Pathways Can Amplify the Effects of Extracellular Signals | |
| | **Unit 2** | **Studying Cell-Surface Receptors and Signal Transduction Proteins**. | CO2, CO6 |
| | A | G Protein–Coupled Receptors: Structure and Mechanism. Protein–Coupled Receptors That Regulate Ion Channels. | |
| | B | G Protein–Coupled Receptors That Activate or Inhibit Adenylyl Cyclase | |
| | C | G Protein–Coupled Receptors That Trigger Elevations in Cytosolic and Mitochondrial Calcium | |
| | **Unit 3** | **Signaling Pathways That Control Gene Expression.** | CO3, CO6 |
| | A | Receptor Serine Kinases That Activate Smads<br>Cytokine Receptors and the JAK/STAT Signaling Pathway<br>Receptor Tyrosine Kinases | |
| | B | The Ras/MAP Kinase Pathway; Phosphoinositide Signaling Pathways | |
| | C | Signaling Pathways Controlled by Ubiquitinoylation and Protein Degradation: Wnt, Hedgehog, and NF-κB | |
| | **Unit 4** | **Cancer- Fundamentals of cancer biology** | CO4, CO6 |
| | A | Introduction to Cancer Biology<br>Modulation of cell cycle in cancer Different forms of cancers, | |
| | B | Cancer screening and early Detection, action using biochemical assays tumor markers molecular tools for early diagnosis of cancer | |
| | C | Theory of Carcinogenesis, Chemical carcinogenesis; Principles of physical carcinogenesis, Mechanisms of radiation carcinogenesis, Nutrition and cancer | |
| | **Unit 5** | **Principles of molecular cell biology of cancer** | CO5, CO6 |
| | A | Signal targets and cancer Activation of kinases Proto oncogenes and oncogenes activity Identification of oncogenes | |
| | B | Retroviruses and oncogenes, Detection of oncogenes, Growth factors related to transformation | |
| | C | Telomerases Tumor suppressor genes Single Nucleotide Polymorphism (SNP) in cancer Molecular tools for identifying cancer genes | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25 % | 75% |
| | Text book/s* | Becker JM, Cold Well GA & Zachgo EA. 2007. Biotechnology a Laboratory Course. Academic Press. | |
| | Other References | Brown CM, Campbell I & Priest FG. 2005. Introduction to Biotechnology. Panima.<br>Singh BD. 2006. Biotechnology Expanding Horiozon. Kalyani. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 1 | 1 | - | - | 2 | - | 2 | 1 | 1 | 2 | 1 |
| **CO2** | 3 | 1 | 1 | 2 | - | - | 2 | - | 2 | 1 | 2 | 2 | 1 |
| **CO3** | 3 | 2 | 1 | 2 | - | - | 3 | - | 3 | 2 | 2 | 3 | 1 |
| **CO4** | 3 | 1 | 1 | 2 | - | - | 3 | - | 3 | 2 | 2 | 3 | 2 |
| **CO5** | 3 | 1 | 1 | 2 | - | - | 3 | - | 3 | 2 | 2 | 3 | 2 |
| **CO6** | 3 | 1 | 1 | 2 | - | - | 2 | - | 3 | 2 | 2 | 3 | 2 |
| **Avg** | 3.0 | 1.2 | 1.0 | 1.8 | - | - | 2.5 | - | 2.7 | 1.7 | 1.8 | 2.7 | 1.5 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons. With Research)** | | **Current Academic Year:2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VII** | |
| **1** | Course Code | **BBI401** | |
| **2** | Course Title | Biostatistics, Bioethics and IPR | |
| **3** | Credits | **4** | |
| **4** | Contact Hours (L-T-P) | **4-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | To understand the concepts of statistics and able to utilize it on the experimental biological data. | |
| **6** | Course Outcomes | The students at the completion of the course will be able to:<br>CO1: Understand the basic concepts of Statistics<br>CO2: Apply the concept of probability and its application<br>CO3: Analyze the correlation and regression using appropriate data<br>CO4: Evaluate and apply the concepts of IPR<br>CO5: To understand the bioethics in biology<br>CO6: Create and evaluate the biostatistics data for biological application | |
| | Course description: | In-depth understanding of statistics as well as to know the basics of bioethics and IPR. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Biostatistics** | CO1,CO6 |
| | A | Introduction to Biostatistics | |
| | B | Frequency distribution: Measures of central tendency: Mean, Median, Mode, standard deviation. | |
| | C | Measures of dispersion: Skewness & Kurtosis | |
| | **Unit 2** | **Probability and Correlation** | CO2, CO6 |
| | A | Probability: definition of probability and binomial distribution (numerical) | |
| | B | Sample, Population, large sample, small sample. Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, difference | |
| | C | Correlation: Definition, Karl Pearson's coefficient of correlation, Simple Regression, | |
| | **Unit 3** | **Hypothesis and Error** | CO3, CO6 |

| | | | |
|---|---|---|---|
| | A | Concept of Test of Hypothesis. Applications of t-test statistics to biological problems/data | |
| | B | Chi square, statistic applications in Biology | |
| | C | Error-I type, Error-II type, Standard error of mean | |
| | **Unit 4** | **IPR** | CO4, CO6 |
| | A | The concept of intellectual property, Importance of IPR in biotechnology, Indian laws and treaties for IPR | |
| | B | Patents-basic concepts, Infringement, compulsory licenses, Exploitation of the Patented Invention, Compulsory Licenses | |
| | C | Copyright and related rights; piracy and infringement and their remedies Definitions, Signs which serve as trademarks | |
| | **Unit 5** | **Bioethics** | CO5, CO6 |
| | A | Introduction to Biosafety, Need for Biosafety in present scenario | |
| | B | Classification and Description of Biosafety Levels, Design of Clean rooms, Design of Biosafety Labs, Biosafety Regulations, | |
| | C | Laws and Policies, Biosafety and Agriculture**,** Genetic Engineering and Health; Genetic Engineering and Food Safety, International Centre for Genetic Engineering and Biotechnology (ICGEB) | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | Fundamental of Statistics by S.C. Gupta, Himalaya Publishing House | |
| | Other References | •Pharmaceutical Statistics- Practical and Clinical Applications by Sanford Bolton, Marcel Dekker Inc. New York.<br>•Design and Analysis of Experiments by R. Pannerselvam, PHI Learning Private Limited.<br>•Design and Analysis of Experiments by Douglas and C. Montgomery, Wiley Students Edition. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 |
| **CO2** | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO3** | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 |
| **CO6** | 1 | 3 | 2 | 2 | - | - | 3 | 2 | 3 | 2 | 1 | 1 | 2 |
| **Avg** | 1.3 | 1.5 | 1.5 | 1.5 | 1.4 | 1.0 | 2.0 | 1.5 | 1.3 | 1.5 | 1.3 | 1.0 | 1.5 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

**Course code: BBI402** **Course Title: Introduction to Nanotoxicology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons. With Research)** | | **Current Academic Year: 2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VII** | |
| **1** | Course Code | **BBI402** | |
| **2** | Course Title | **Introduction to Nanotoxicology** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | DSE | |
| **5** | Course Objective | The objective of Nano-toxicology is to understand the inorganic-based nanomaterials, carbon-based nanomaterials, organic-based nanomaterials; and composite-based nanomaterials. Students will be able to understand the effects of nano particulates on human system. | |
| **6** | Course Outcomes | The student at the completion of the course will be able to:<br>CO1: Understand the concepts of nanomaterials and toxicity.<br>CO2: To apply the knowledge of nanomaterials on human health<br>CO3: To analyse the toxicity of nanomaterials.<br>CO4: Evaluate the role of various factors and their effects on the level of nanotoxicity<br>CO5: Apply the knowledge of risk and reach analysis emphasizing the role of regulatory guidelines<br>CO6: Create the knowledge of toxicity with reference to nanomaterials prior to clinical use | |
| **7** | Course Description | Nanotoxicology is a new area of study that deals with the toxicological profiles of nanomaterials (NMs). Compared with the larger counterparts, the quantum size effects and large surface area to volume ratio brings NMs their unique properties that may or may not be toxic to living things | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Nanomaterials and Nanotoxicology** | CO1,CO6 |
| | A | Natural and synthetic nanomaterials. | |
| | B | Biological and Environmental applications of nanomaterials, | |
| | C | Study of nano-bio interface | |
| | **Unit 2** | **Nanotoxicity and human health** | CO2, CO6 |
| | A | Fate of nanomaterials in human body: short term and long-term effects, | |
| | B | Acute and chronic toxicity, | |
| | C | Study of different levels toxicity based on organs | |
| | **Unit 3** | **Determination of nanotoxicity** | CO3, CO6 |

| | | | |
|---|---|---|---|
| | A | In vitro, in vivo, and ex vivo models to study the effects of nanomaterials on mammalian cells and tissues | |
| | B | Histological Analysis | |
| | C | hematological analysis, serum biochemical analysis | |
| | **Unit 4** | **Factors for determining nanotoxicity** | CO4, CO6 |
| | A | Size, shape, charge, aggregation, and interaction behavior of nanomaterials for determining the toxicity level, | |
| | B | Nanomaterials interactions with serum proteins | |
| | C | protein-corona formation | |
| | **Unit 5** | **Regulatory guidelines for nanomaterials** | CO5, CO6 |
| | A | Risk assessment analysis, | |
| | B | Regulatory guidelines like ISO guidelines, | |
| | C | ASTM guidelines, CDSO and reach analysis | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | | |
| | Other References | Nanotoxicity: From In Vivo and In Vitro Models to Health Risks, Editor(s): Saura C. Sahu Daniel A.<br>Casciano 2- Nanotoxicity Methods and Protocols, Editors Joshua Reineke 3- Recent research articles | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 |
| **CO2** | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 1 | 1 | 1 |
| **CO3** | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO4** | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 |
| **CO5** | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 2 |
| **CO6** | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| **Avg** | 2.0 | 1.5 | 1.5 | 1.0 | 1.0 | 1.0 | 1.7 | 1.8 | 1.0 | 1.8 | 1.8 | 1.8 | 1.5 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

| | | | | |
|---|---|---|---|---|
| **School: SSBSR** | | **Batch:**2023-27 | | |
| **Programme: B.Sc (Hons. With Research)** | | **Current Academic Year:2023-24** | | |
| **Branch: Biotechnology** | | | | |
| **1** | **Course Code** | **CHE101** | | |
| **2** | **Course Title** | **Fundamentals of Chemistry** | | |
| **3** | **Credits** | 4 | | |
| **4** | **Contact Hours (L-T-P)** | 4-0-0 | | |
| **5** | **Course Type** | Minor | | Theory |
| **6** | **Course Objective** | Students will gain an understanding of<br>1. Molecular polarity and weak chemical forces.<br>2. Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters.<br>3. Periodic properties of elements.<br>4. The basics of organic chemistry give the most primary and utmost important knowledge and concepts of organic Chemistry, theoretical picture in multiple stages in an overall chemical reaction.<br>5. Reactive intermediates, transition states and states of all the bonds broken and formed, reaction mechanism.<br>6. Stereochemistry of simple organic molecules. | | |
| **7** | **Course Outcomes** | After the completion of course the student will be able to:<br>CO1: explain molecular polarity and weak chemical forces<br>CO2: describe simple bonding theories of molecules.<br>CO3: discuss periodic properties of elements and recapitulate basics of Organic Chemistry<br>CO4: explain mechanism of organic reactions.<br>CO5: illustrate stereochemistry of simple organic molecules.<br>CO6: apply the knowledge to solve simple scientific problems. | | |
| **8** | **Course Description** | This course includes introduction to Indian ancient Chemistry and the contribution of Indian Chemists, describes molecular polarity, weak chemical forces, chemical bonding, periodic properties of elements, organic reaction intermediate, reaction mechanism, stereochemistry. | | |
| **9** | **Outline Syllabus** | | | CO Mapping |
| | **Unit 1** | | | |
| | **A** | Introduction to Indian Ancient Chemistry and contribution of Indian Chemists.<br>**Molecular Polarity and Weak Chemical Forces**<br>Formal charge, Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment. | | CO1 |

| | | | |
|---|---|---|---|
| | **B** | Polarizing power and polarizability. Fajan's rules and consequenceof polarization. Hydrogen bonding. | CO1, CO6 |
| | **C** | Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process. Lattice energy and Born-Haber cycle, solvation energy, and solubility of ionic solids. | CO1, CO6 |
| | **Unit 2** | **Simple Bonding theories of Molecules** | |
| | **A** | Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach), valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry. | CO2, CO6 |
| | **B** | Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: $H_2O$, $NH_3$, $PCl_5$, $SF_6$, $SF_4$, $ClF_3$, $I_3^-$, $ClF_2^{--}$. | CO2, CO6 |
| | **C** | Molecular orbital theory (MOT). Molecular orbital diagrams, bond orders of homonuclear and heteronuclear diatomic molecules and ions ($N_2$, $O_2$, $C_2$, $B_2$, $F_2$, CO, NO, and their ions). | CO2, CO6 |
| | **Unit 3** | **Basics properties of elements and introduction to Organic chemistry** | |
| | **A** | **Periodic Properties of Elements**<br>Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy. | CO3, CO6 |
| | **B** | **Recapitulation of Basics of Organic Chemistry**<br>Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Van der Waals interactions, inclusion compounds, Clathrates, Charge transfer complexes, hyperconjugation, Dipole moment | CO3, CO6 |
| | **C** | Electronic Displacements: Inductive, electromeric, resonance, mesomeric effects and their applications | CO3 , CO6 |
| | **Unit 4** | **Mechanism of Organic Reactions** | |
| | **A** | Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles. | CO4 |
| | **B** | Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). | CO4, CO6 |
| | **C** | Types of organic reactions, Energy considerations. | CO4, CO6 |
| | **Unit 5** | **Concept of isomerism** | |
| | **A** | Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation. | CO5, CO6 |
| | **B** | Relative and absolute configuration, sequence rules, D & L and R & | CO5, |

| | | | |
|---|---|---|---|
| | | S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. | CO6 |
| | **C** | Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds | CO5, CO6 |
| | **Mode of examination** | Theory | |
| | **Weightage Distribution** | CA: 25% | ESE: 75% |
| | **Text Book/s *** | 1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010.<br>2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).<br>3. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc. | |
| | **Other References** | 1. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970.<br>2. Carey, F. A., Guiliano, R. M.Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.<br>3. Clayden, J., Greeves, N. &Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.<br>4. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **1** | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO2** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO3** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO4** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO5** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **CO6** | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - |
| **Avg** | 1.0 | 1.0 | - | - | - | - | - | - | 2.0 | - | - | - | - |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

**Course code: BBI404** **Course Title: Introduction to Nanotoxicology Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc. (Hons. With Research)** | | **Current Academic Year: 2026-2027** |
| **Branch: Biotechnology** | | **SEMESTER: VII** |
| **1** | Course Code | **BBI404** |
| **2** | Course Title | **Introduction to Nanotoxicology Lab** |
| **3** | Credits | **2** |
| **4** | Contact Hours (L-T-P) | **0-0-4** |
| | Course Status | DSE |
| **5** | Course Objective | The objective of Nano-toxicology is to understand the inorganic-based nanomaterials, carbon-based nanomaterials, organic-based nanomaterials; and composite-based nanomaterials. Students will be able to understand the effects of nano particulates on human system. |
| **6** | Course Outcomes | After the completion of course the student will be able to:<br>**CO1:** To studying the development of various nanomaterials<br>**CO2:** To examine the physicochemical properties of nanomaterials<br>**CO3:** To determine the nanotoxicity on in vitro models<br>**CO4:** Determining the nano-bio interface at protein levels<br>**CO5:** To analyse the nanomaterial toxicity using bioinformatics approaches<br>**CO6:** Overall studying the physicochemical parameters of nanomaterials and emphasizing their role on nanotoxicity |
| **7** | Course Description | Nanotoxicology is a new area of study that deals with the toxicological profiles of nanomaterials (NMs). Compared with the larger counterparts, the quantum size effects and large surface area to volume ratio brings NMs their unique properties that may or may not be toxic to living things |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Development of nanomaterials** | |
| | A | Introduction to Nanotoxicology Lab; GLP | CO1, CO6 |
| | B | Fabrication of organic (polymer) nanomaterials via different methodological approaches | CO1,CO6 |
| | C | Fabrication of inorganic (metal/metal oxide) nanomaterials via different methodological approaches | CO1,CO6 |
| | **Unit 2** | **Physicochemical characterization analysis** | |

| | | | |
|---|---|---|---|
| | A | Determining the surface plasmon resonance property | CO2, CO6 |
| | B | Determining the magnetization, size, shape, crystanillity. | CO2, CO6 |
| | C | Determining the particle composition and thermal analysis | CO2, CO6 |
| | **Unit 3** | **Determination of nanotoxicity on in vitro models** | |
| | A | Introduction to nanomaterial Toxicity | CO3, CO6 |
| | B | Studying the nanomaterial toxicity on mouse fibroblast cells (MTT test) | CO3, CO6 |
| | C | Studying the hemocompatibility of nanomaterial | |
| | **Unit 4** | **Toxic effects of nanomaterials on serum proteins** | |
| | A | Nanoparticle-protein interaction study | CO4, CO6 |
| | B | Nanoparticle-protein degradation and conformational change analysis | CO4, CO6 |
| | C | Nanoparticle-protein protein-corona analysis | CO4, CO6 |
| | **Unit 5** | **Bioinformatic analysis of nanomaterial toxicity** | |
| | A | Determining the effects of nanomaterials on various structural and functional proteins. | CO5, CO6 |
| | B | Effects of nanomaterials on DNA damage | CO5, CO6 |
| | C | Oxidative stress analysis | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | |
| | Weightage Distribution | CA / CE / ESE | |
| | | 25% / 25% / 50% | |
| | Text books | Nanotoxicity: From In Vivo and In Vitro Models to Health Risks, Editor(s): Saura C. Sahu Daniel A. Casciano<br>Nanotoxicity Methods and Protocols, Editors Joshua Reineke | |
| | Reference books | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 |
| **CO2** | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 1 | 1 | 1 |
| **CO3** | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO4** | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 |
| **CO5** | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 2 |
| **CO6** | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| **Avg** | 2.0 | 1.5 | 1.5 | 1.0 | 1.0 | 1.0 | 1.7 | 1.8 | 1.0 | 1.8 | 1.8 | 1.8 | 1.5 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons. With Research)** | | **Current Academic Year: 2026-27** | |
| **Branch: Biotechnology** | | **SEMESTER: VII** | |
| **1** | Course Code | **BBI414** | |
| **2** | Course Title | **Fundamental Bioinformatics** | |
| **3** | Credits | **3** | |
| **4** | Contact Hours (L-T-P) | **3-0-0** | |
| | Course Status | Compulsory | |
| **5** | Course Objective | To teach the basic concept of Bioinformatics, databases and sequence analysis<br>To develop understanding of sequence analysis<br>To provide knowledge of scoring matrix and Detection of functional sites etc.<br>To impart knowledge related to phylogenetic analysis protein structure prediction | |
| **6** | Course Outcomes | After successfully completion of this course students will be able to:<br>CO1: Understand concepts and application of Bioinformatics, types of databases, sequence similarity, sequence patterns and profiles<br>CO2: Apply the sequence alignment techniques, database searching, pairwise and multiple sequence alignment using various tools.<br>CO3: Develop scoring matrices and its types including PAM, BLOSUM series and matrices for nucleic acid and protein sequences<br>CO4: Apply phylogeny and its concepts in molecular evolution and different methods of Phylogenetic tree construction<br>CO5:To create the protein structure using sequences prediction and knowledge of bioinformatics in drug designing<br>CO6:To evaluate the structure of proteins using computational approach | |
| | Course Description | Industrial biotechnology includes modern application of biotechnology for sustainable processing and production of chemical products, materials and fuels. Biotechnological processing uses enzymes and microorganisms to produce products that are useful to a broad range of industrial sectors, including chemical and pharmaceutical, human and animal nutrition, pulp and paper, textiles, energy, materials and polymers, using renewable raw materials. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Bioinformatics** | CO1,CO6 |
| | A | Biological databases: Nucleotide databases, Protein databases, Specialized databases | |
| | B | Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, FASTA etc.; | |
| | C | Basic concepts of sequence similarity: identity and homology. | |
| | **Unit 2** | **Tools for sequence alignment** | CO2, CO6 |

| | | | |
|---|---|---|---|
| | A | Sequence Alignment and Database Searching: Introduction, Evolutionary Basis of Sequence Alignment, Optimal alignment method | |
| | B | Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment | |
| | C | Tools for multiple sequence alignment. | |
| | **Unit 3** | **Scoring matrix** | CO3, CO6 |
| | A | Scoring Matrices: Basic concept of a scoring matrix | |
| | B | Similarity and distance matrix, Substitution matrices | |
| | C | Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series | |
| | **Unit 4** | Phylogenetics | CO4, CO6 |
| | A | Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny | |
| | B | definition and description of Phylogenetic trees and various types of trees | |
| | C | Different methods of Phylogenetic tree construction | |
| | **Unit 5** | **Protein identification** | CO5, CO6 |
| | A | Protein identification based on composition, Physical properties based on sequence, Motif and pattern | |
| | B | Secondary structure (Statistical method: Chou Fasman and GOR method) | |
| | C | Tertiary structures **(**Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.); Application of bioinformatics in drug discovery and drug designing. | |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA+MSE | ESE |
| | | 25% | 75% |
| | Text book/s* | D.W.Mount; Bioinformatics-Sequence and genome analysis; Cold Spring Harbour Lab press. 2001 | |
| | Other References | B.N.Mishra; Bioinformatics: Concept and application, Pearson Education 2020<br>O' Reilly; Developing Bioinformatics computer skills-1stIndian edition, SPD publication.2001<br>Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1stEd 1976<br>Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press 2001 | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 |
| **CO3** | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| **CO4** | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 |
| **CO6** | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 |
| **Avg** | 2.0 | 1.7 | 1.7 | 3.0 | 1.0 | 1.0 | 1.8 | 1.5 | 1.0 | 2.0 | 1.5 | 1.5 | 1.5 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

**Course code: BBI415** **Course Title: Fundamental Bioinformatics Lab**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc. (Hons. With Research)** | | **Current Academic Year: 2026-2027** |
| **Branch: Biotechnology** | | **SEMESTER: VIII** |
| **1** | Course Code | **BBI415** |
| **2** | Course Title | **Bioinformatics Lab** |
| **3** | Credits | **1** |
| **4** | Contact Hours (L-T-P) | **0-0-2** |
| | Course Status | DSE |
| **5** | Course Objective | • To retrieval of the sequence data<br>• Demonstration of locating the chromosome and retrieval of gene expression data<br>• To provide practical knowledge for retrieval of PubMed data.<br>• Practical knowledge of ORF finding, motif information and retrieval of Gene information |
| **6** | Course Outcomes | After the completion of course the student will be able to:<br>CO1: Practical knowledge of retrieving data<br>CO2: Locating the chromosome of a gene<br>CO3: Finding ORF of a given sequence.<br>CO4: Retrieving motif information of a protein<br>CO5: Retrieving Gene Information |
| **7** | Course Description | Students should be able to demonstrate the retrieval of sequence data **a**nd Perform experiments related to locating chromosome and gene expression data. They will be able to learn Different tools of PubMed. Also**,** able to Perform the ORF finding and retrieval of gene information. |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Introduction to basic tools of Bioinformatics** | |
| | A | Retrieving sequence data from Entrez | CO1, CO6 |
| | B | Retrieve gene expression data from GEO | CO1,CO6 |
| | C | Retrieving articles using PubMed | CO1,CO6 |
| | **Unit 2** | **Sequence Alignment** | |
| | A | BLAST; Types of BLAST | CO2, CO6 |
| | B | Multiple Sequence alignment | CO2, CO6 |

| | | | |
|---|---|---|---|
| | C | Construct Phylogenetic tree | CO2, CO6 |
| | **Unit 3** | **Prediction tools-1** | |
| | A | Locating the chromosome of a Gene | CO3, CO6 |
| | B | Finding ORF of a Given Sequence | CO3, CO6 |
| | C | Prediction of secondary structure of RNA using any web server. | CO3, CO6 |
| | **Unit 4** | **Protein Databases** | |
| | A | Introduction to protein databases | CO4, CO6 |
| | B | Retrieving structural data of a protein using PDB database | CO4, CO6 |
| | C | Retrieving Motif Information of a Protein Using Prosite | CO4, CO6 |
| | **Unit 5** | **Prediction tools -2** | |
| | A | Retrieving Gene Information from TAIR database | CO5, CO6 |
| | B | Construction and analysis of Ramachandran Plot using any suitable web server | CO5, CO6 |
| | C | Comparative assessment of best available tools for genome annotation | CO5, CO6 |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks<br>ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | |

| | | | | | |
|---|---|---|---|---|---|
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | P. F. Stanbury, S. J. Hall and A. Whitaker, Principles of Fermentation Technology, IInd Edn.,Elsevier, Science & Technology Books, 2005.<br>B. D. Singh (2009, Revised edition) Biotechnology- Expanding Horizons. Kalyani publishers, Ludhiana-141008 | | | |
| | Reference books | | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 1 | 1 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO3** | 2 | 1 | 1 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| **CO4** | 2 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO6** | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **Avg** | 1.8 | 1.0 | 1.2 | 3.0 | 1.0 | 1.0 | 1.5 | 1.0 | 1.0 | 1.7 | 1.5 | 1.5 | 1.5 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

# SEMESTER VIII
# Bachelor (Honours with Research) in Biotechnology

**Course code: FST419** **Course Title: Basic Concepts of Research Design and Methodology**

| | | | |
|---|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** | |
| **Programme: B.Sc. (Hons with Research)** | | **Current Academic Year: 2026-27** | |
| **Branch:** Food Science and Technology | | **SEMESTER: 8th** | |
| **1** | Course Code | **FST 419** | |
| **2** | Course Title | Basic Concepts of Research Design and Methodology | |
| **3** | Credits | 4 | |
| **4** | Contact Hours (L-T-P) | 4-0-0 | |
| | Course Status | Compulsory | |
| **5** | Course Objective | 1. To understand the various research concepts<br>2. To understand the research design, hypothesis and selecting the research problem.<br>3. To learn the sampling procedure and data collection.<br>4. To learn the data interpretation, data analysis, writing research project. | |
| **6** | Course Outcomes | After successful completion of this course students will be able to:<br>CO1: Define various research concepts<br>CO2: Explain research design, hypothesis and selecting the research problem<br>CO3: Identify and discuss the concepts and procedure of sampling, data collection.<br>CO4: Identify, explain compare and prepare the key element of a research proposal and report<br>CO5: Evaluate the data interpretation and data analysis.<br>CO6: Demonstrate the knowledge of research process, research design and complete research hypothesis in research methodology. | |
| **7** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Basics of Research in Food Science** | CO1,CO6 |
| | A | Exploration, Description, Explanation, Scientific method and research. | |
| | B | Research Designs –Experimental and Observational, Quantitative and Qualitative approaches | |
| | C | Conceptualization and Measurement, Variables, concepts and measurement. | |
| | **Unit 2** | **Sampling & Tools** | CO2, CO6 |
| | A | Role of sampling in research, Types of sampling | |
| | B | Research Tools and Techniques, Validity and reliability | |
| | C | Interviewing and observational methods | |
| | **Unit 3** | **Research Process** | CO3, CO6 |

| | | | |
|---|---|---|---|
| | A | Defining the problem, research questions, objectives, hypotheses, Review of related literature and originality in writing | |
| | B | Planning the research, Subjects context and ethics, Methodology, and tools | |
| | C | Citation formats: in biological sciences. | |
| | **Unit 4** | **Sampling Process** | CO4, CO6 |
| | A | Exercise in sampling, Random Number Table, Exercise in designing tools and their analysis | |
| | B | Interview and Questionnaire method | |
| | C | Data collection Process: Conducting interviews, FGDs (focus on group discussion) | |
| | **Unit 5** | **Data Collection** | CO5, CO6 |
| | A | Levels of measurement | |
| | B | Units of analysis, Case studies | |
| | C | Result Interpretation | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | Internal (CA+MSE) | External (ESE) |
| | | **25%** | **75%** |
| | Text book/s* | 1. Kumar, R. (2005) Research Methodology: A Step-by-Step Guide for Beginners. Sage<br>2. Kothari C.R. (2008) Research Methodology: Methods and Techniques 2nd Ed New Age-International Pvt Tld, New Delhi. | |
| | Other References | 1.Kerlinger F.N. and Lee, H.B. (2000) Foundations of Behavioural Research 4th Ed. Harcour College Publishers<br>2. Black J.A. & Champion, D.J. (1976) Methods and Issue in Social Research. New York Wiley and Sons. | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 1 | 1 | 1 | - | 2 | 1 | 2 | 1 | - | - | 1 |
| **CO2** | 1 | 3 | 1 | 1 | 1 | - | 2 | 1 | 2 | 1 | - | - | 1 |
| **CO3** | 2 | 3 | 2 | 3 | 1 | - | 3 | 2 | 2 | 2 | - | - | 2 |
| **CO4** | 1 | 2 | 1 | 2 | 1 | - | 2 | 1 | 2 | 1 | - | - | 2 |
| **CO5** | 2 | 3 | 1 | 3 | 1 | - | 3 | 2 | 2 | 2 | - | - | 2 |
| **CO6** | 2 | 3 | 2 | 3 | 1 | - | 3 | 2 | 2 | 2 | - | - | 3 |
| **Avg** | 1.7 | 2.8 | 1.3 | 2.2 | 1.0 | - | 2.5 | 1.5 | 2.0 | 1.5 | - | - | 1.8 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***

**Course code: PJI402** **Course Title: Project**

| | | |
|---|---|---|
| **School: SSBSR** | | **Batch: 2023-27** |
| **Programme: B.Sc. (Hons with Research)** | | **Current Academic Year: 2026-27** |
| **Branch: Biotechnology** | | **SEMESTER: VI** |
| **1** | Course Code | PJI402 |
| **2** | Course Title | **Project** |
| **3** | Credits | **9** |
| **4** | Contact Hours (L-T-P) | **0-0-18** |
| | Course Status | Compulsory |
| **5** | Course Objective | Develop knowledge of a specific area of specialization.<br>Develop research skills especially in biological experiments, project writing andoral presentation |
| **6** | Course Outcomes | After the completion of course the student will be able to:<br>**CO1:** Recognize research-based investigation carried out on biology and interdisciplinary science<br>**CO2:** Literature survey on the research problem<br>**CO3:** Demonstrate capacity to conduct experiments and extract important results of research findings<br>**CO4:** Able to write the project/paper<br>**CO5:** Presentation on the research work done<br>**CO6:** Understand and execute the project in terms of experiments and project writing |
| **7** | Course Description | Project aims to promote and develop student competencies related to research practice and to benefit students through activities linked to research. |

| 8. | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Identify a research question** | **CO1,CO6** |
| | **Unit 2** | **Literature survey** | **CO2,CO6** |
| | **Unit 3** | **Conduct Experiments and data analysis** | **CO3,CO6** |
| | **Unit 4** | **Project writing** | **CO4,CO6** |
| | **Unit 5** | **Presentation** | **CO5 ,CO6** |
| | Mode of examination | Continuous Assessment (CA): 25 Marks<br>Viva-Voce (on the basis of weekly Viva performance): 25 Marks | |

| | | | | | |
|---|---|---|---|---|---|
| | | ESE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks) | | | |
| | Weightage Distribution | CA | CE | ESE | |
| | | 25% | 25% | 50% | |
| | Text books | 10 Recent International Journal Articles of repute. | | | |

**CO-PO-PSO Mapping**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| **CO2** | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| **CO4** | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| **CO5** | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 2 |
| **CO6** | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 |
| **Avg** | 1.5 | 2.0 | 1.5 | 1.8 | 1.2 | 1.0 | 1.7 | 1.8 | 1.8 | 1.2 | 2.3 | 1.7 | 1.7 |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3. Substantial (High)***