# SRM University-*AP*, Andhra Pradesh 522 240

## B.Sc. Integrative Biology (Honors with Research)

## 4 years Program

**Course Structure and Syllabus**

**(2024 onwards)**

**Department of Biological Sciences**

**SRM University-*AP***

**Neerukonda,**

**Mangalagiri Mandal**

**Guntur District,**

**Andhra Pradesh - 522 240**

## Semester Wise Credit Distribution Under Various Categories

| Course Type | Sem 1 | Sem 2 | Sem 3 | Sem 4 | Sem 5 | Sem 6 | Sem 7 | Sem 8 | Total | Percentage |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ability Enhancement Courses (AEC)** | 2 | 2 | 2 | 2 | | | | | 8 | **5** |
| **Value Added Courses (VAC)** | 2 | 2 | 4* | 4* | 4* | 4 | | | 8 | **5** |
| **Skill Enhancement Courses** | 3 | 2 | 2 | 2 | 3 | 3 | | | 15 | **9.375** |
| **Multidisciplinary / Interdisciplinary /Foundation Core (MIC/FIC)** | 11 | 6 | | | | | | | 17 | **10.625** |
| **Majore Core+Specialization (CC)** | | 8 | 17 | 12 | 16 | 16 | 12 | | 81 | **50** |
| **Minor (MC)/Open Elective (OE)** | | | 3 | 3 | 3 | 3 | 3 | | 15 | **9.375** |
| **Research/ Design/ Industrial Practice/ Project (RDIP)** | | | | | | | 5 | 12 | 17 | **10.625** |
| **Total** | **18** | **20** | **24** | **19** | **22** | **26** | **20** | **12** | **161** | **100** |

| Sem | Course Code | Course name | L | T | P | C |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1 | AEC101 | Art of Listening, Speaking and Reading Skills | 1 | 0 | 1 | 2 |
| 1 | VAC101 | Environmental Science | 2 | 0 | 0 | 2 |
| 1 | SEC101 | Analytical Reasoning and Aptitude Skills | 1 | 1 | 1 | 3 |
| **1** | **FIC111** | **Chemical Basis of Life** | **3** | **0** | **0** | **3** |
| 1 | FIC112 | Mathematics for the physical world | 2 | 1 | 0 | 3 |
| 1 | FIC113 | Fundamentals of computing | 2 | 0 | 1 | 3 |
| 1 | FIC101 | Emerging technologies | 2 | 0 | 0 | 2 |
| | | | | | | **18** |
| | | | | | | |
| 2 | AEC107 | Effective Writing and Presentation Skills | 2 | 0 | 2 | 2 |
| 2 | VAC102 | Universal Human Values and Ethics | 2 | 0 | 2 | 2 |
| 2 | SEC103 | Entrepreneurial Mindset | 0 | 0 | 2 | 2 |
| 2 | FIC107 | Principles of Management | 3 | 0 | 0 | 3 |
| 2 | FIC124 | Psychology for everyday living | 3 | 0 | 0 | 3 |
| **2** | **BIO101** | **Biomolecules** | **2** | **1** | **0** | **3** |
| **2** | **BIO102** | **Basic concepts in Microbiology** | **2** | **1** | **0** | **3** |
| **2** | **BIO 103** | **Microbiology Lab** | **0** | **0** | **2** | **2** |
| | | | | | | **20** |
| | | | | | | |
| 3 | AEC 106 | Analytical Skills for Sciences | 1 | 0 | 1 | 2 |
| 3 | VAC | Co-Curricular Activities | 0 | 0 | 2 | 2* |
| 3 | VAC | Community Service and Social Responsibility | 1 | 0 | 1 | 2* |
| 3 | SEC 102 | Digital Literacy | 1 | 0 | 1 | 2 |
| 3 | BIO 201 | Metabolism of Biomolecules | 2 | 1 | 0 | 3 |
| 3 | BIO 202 | Cell Biology | 3 | 1 | 0 | 4 |
| 3 | BIO 203 | Concepts of Genetics | 3 | 1 | 0 | 4 |
| 3 | BIO 204 | Evolutionary Biology | 3 | 1 | 0 | 4 |
| 3 | BIO208 | Biochemistry Lab | 0 | 0 | 2 | 2 |
| | OE | OE | | | | 3 |
| | | | | | | **24** |
| | | | | | | |
| 4 | AEC 104 | Creativity and Critical thinking Skills | 1 | 0 | 1 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | VAC | Co-Curricular Activities | 0 | 0 | 2 | 2* |
| 4 | VAC | Community Service and Social Responsibility | 2 | 0 | 0 | 2* |
| 4 | SEC 106 | Leadership for Professionals | 2 | 0 | 0 | 2 |
| 4 | BIO 205 | Concepts of Molecular Biology | 2 | 1 | 0 | 3 |
| 4 | BIO 206 | Experimental Methods in Biology | 3 | 1 | 0 | 4 |
| 4 | BIO 207 | Introductory Biophysics | 2 | 1 | 0 | 3 |
| | BIO 209 | Molecular Biology Lab | 0 | 0 | 2 | 2 |
| 4 | OE | OE | | | | 3 |
| | | | | | | **19** |
| | | | | | | |
| 5 | VAC | Co-Curricular Activities | 0 | 0 | 2 | 2* |
| 5 | SEC | Career Skills I | 2 | 0 | 1 | 3 |
| 5 | VAC | Community Service and Social Responsibility | 2 | 0 | 0 | 2* |
| 5 | BIO 301 | Introduction to Developmental Biology | 3 | 1 | 0 | 4 |
| 5 | BIO 302 | Genetic Engineering | 2 | 1 | 0 | 3 |
| 5 | BIO 303 | Immunobiology | 2 | 1 | 0 | 3 |
| 5 | BIO 304 | Genetic Engineering Lab | 0 | 0 | 2 | 2 |
| 5 | BIO 305 | Plant and Animal Physiology | 3 | 1 | 0 | 4 |
| 5 | OE/Minor | OE | | | | 3 |
| | | | | | | **22** |
| | | | | | | |
| 6 | VAC | Co-Curricular Activities | 0 | 0 | 2 | 2* |
| 6 | SEC | Career Skills II | 2 | 0 | 1 | 3 |
| 6 | VAC | Community Service and Social Responsibility | 1 | 0 | 1 | 2* |
| 6 | BIO 306 | Introduction to Biotechnology | 2 | 1 | 0 | 3 |
| 6 | BIO 307 | Fundamentals of Bioinformatics | 2 | 1 | 0 | 3 |
| 6 | BIO 308 | Neurobiology | 3 | 1 | 0 | 4 |
| 6 | BIO 309 | Introduction to Disease Biology | 3 | 1 | 0 | 4 |
| | BIO 310 | Bioinformatics Lab | 0 | 0 | 2 | 2 |
| 6 | OE/Minor | OE | | | | 3 |
| | | | | | | **26** |
| | | | | | | |
| 7 | BIO 401 | Minor Research Project | 0 | 0 | 5 | 5 |
| 7 | BIO 402 | Signal Transduction (Core elective) | 4 | 0 | 0 | 4 |
| 7 | BIO 403 | Introduction to Omics (Core elective) | 4 | 0 | 0 | 4 |
| 7 | BIO 404 | Cancer and Stem Cell Biology (Core elective) | 4 | 0 | 0 | 4 |
| 7 | OE/Minor | OE | | | | 3 |
| | | | | | | **20** |
| | | | | | | |
| 8 | BIO 405 | Research Degree Project | 0 | 0 | 12 | **12** |

**OE/Minors**: These courses are offered to the students of other departments across the disciplines.
Cell Biology
Basic Microbiology
Human Physiology
Molecular Biology
Bioinformatics
Introductory Biology

# SEMESTER 1

# SRM University – AP, Andhra Pradesh

Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

## Chemical Basis of Life

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **FIC 111** | Course Category | **Core Course (CC)** | L-T-P/Pr-C | **3** | **0** | **0** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences/ Chemistrty** | Professional / Licensing Standards | | | | | | |
| Board of Studies Approval Date | | Academic Council Approval Date | | | | | | |

### Course Objectives / Course Learning Rationales (CLRs)

1. To learn the origin and composition of complex biomolecules and primitive cells, focusing on the chemical reactions that drive the force of life
2. To gain foundational knowledge in chemical thermodynamics, covering the basic principles of energy, work, and heat, and understanding the first and second laws of thermodynamics, entropy, spontaneity, reversibility, disorder, and the calculation of Gibbs free energy.

### Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | List and describe biomolecules and cellular structures | 2 | 70% | 65% |
| **Outcome 2** | Compare different chemical bonding concepts | 2 | 70% | 65% |
| **Outcome 3** | Analyze and explain cellular processes and structures | 4 | 50% | 50% |
| **Outcome 4** | Apply thermodynamic principles to chemical systems | 3 | 70% | 65% |
| **Outcome 5** | Interpret and evaluate energy harvesting reactions in life | 6 | 50% | 50% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | 1 | | | | 3 | | 3 | 3 | 1 | 2 |
| Outcome 2 | 3 | 3 | 3 | 3 | 1 | 1 | | | 1 | | | 3 | 3 | 3 | 2 |
| Outcome 3 | 3 | 3 | 3 | 2 | 1 | 1 | | | 1 | | | 2 | 3 | 2 | 3 |
| Outcome 4 | 3 | 2 | 3 | 3 | 1 | 1 | | | 1 | | | 3 | 3 | 3 | 3 |
| Outcome 5 | 3 | 3 | 3 | 3 | 1 | 1 | | | 2 | 3 | | 3 | 3 | 2 | 3 |
| **Course Aver** | **3** | **2.6** | **3** | **2.8** | **1** | **1** | | | **1.3** | **3** | | **2.8** | **3** | **2.2** | **2.6** |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **age** | | | | | | | | | | | | | | | |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| **Unit 1** | **Life: Origin, composition, and chemistry** | **9** | | |
| | Origin of complex biomolecules and primitive cells | 1.5 | 1 | 1, 2 |
| | Chemical basis of life- Importance of carbon & water | 1.5 | 1 | 1, 2 |
| | Synthesis by polymerization; importance of self-assembly; Selectively permeable membranes | 1.5 | 1 | 1, 2 |
| | Concepts of acids, bases, and buffers | 1.5 | 1 | 3 |
| | Concepts and numerical problems on pH, $K_a$, $K_b$, $K_w$ | 1.5 | | 2, 3 |
| | Henderson-Hasselbalch equation | 1.5 | 1 | 1, 2, 3 |
| **Unit 2** | **Chemical bonding** | **9** | | |
| | Definition and importance; Valence electrons and their role in bond formation | 1.5 | 2 | 3 |
| | Introduction of Lewis dot structure; Covalent bonds- single, double, and triple bonds | 1.5 | | |
| | Electronegativity and polarity in covalent bonds; Ionic bonds- transfer of electrons, cations and anions | 1.5 | 2 | 3 |
| | An elementary idea of lattice structure | 1.5 | | 3 |
| | Weak intermolecular associations. Coord bonds. | 1.5 | 2 | 3 |
| | Comparison of bond strengths of different bonds with special relation to biological systems. | 1.5 | 2 | 3 |
| **Unit 3** | **Life forms and processes** | **9** | | |
| | Prokaryotes and eukaryotes (cell structures and organelles); Virus- lysogenic and lytic cycles | 1.5 | 3 | 1, 2 |
| | Bacteria- typical bacterial cells, bacterial gene transfer- conjugation, transformation, and transduction | 1.5 | 3 | 1, 2 |
| | Antibiotic resistance- an emerging threat; Microbiome; Cell cycle- mitosis and meiosis | 1.5 | 3 | 1, 2 |
| | Structure of DNA and organization of chromosomes | 1.5 | 3 | 1, 2 |
| | Central dogma- replication in prokaryotes | 1.5 | 3 | 1, 2 |
| | Central dogma- transcription, and translation in prokaryotes | 1.5 | 3 | 1, 2 |

| | | | | |
|---|---|---|---|---|
| **Unit 4** | **Chemical thermodynamics** | **9** | | |
| | Introduction to energy, work and heat in chemical systems; Differentiating between open, closed, and isolated systems | 1.5 | 4 | 3 |
| | First law of thermodynamics: conservation of energy, calculation of internal energy changes, concept of enthalpy | 1.5 | 4 | 3 |
| | Second law of thermodynamics: definition, concept of entropy, calculation and interpretation of entropy changes | 1.5 | 4 | 3 |
| | Spontaneity, reversibility, and disorder | 1.5 | 4 | 3 |
| | Gibbs free energy: calculation, predicting feasibility of reaction | 1.5 | 4 | 2, 3 |
| | Concept of chemical equilibrium | 1.5 | 4 | 1, 2, 3 |
| **Unit 5** | **Energy harvesting reactions by life forms** | **9** | | |
| | Biological reactions: Enzymes | 1.5 | 5 | 1, 2 |
| | Equilibrium constants ($K_{eq}$) of enzymes | 1.5 | 5 | 1, 2 |
| | Metabolism: Glycolysis | 1.5 | 5 | 1, 2 |
| | Anaerobic respiration | 1.5 | 5 | 1, 2 |
| | Aerobic cellular respiration | 1.5 | 5 | 1, 2 |
| | Fate of food in cellular energy cycle. | 1.5 | 5 | 1, 2 |
| **Total Contact Hours** | | **45** | | |

## Recommended Resources

1. Becker's World of the Cell, Global Edition, 9th Edition (2017). Jeff Hardin, Gregory Paul Lewis J. Kleinsmith.Pearson. ISBN-13: 978-1292177694.
2. Life: The Science of Biology, 11th Edition (2017). David Sadava, David M. Hillis, H. Craig Heller, Sally D. Hacker. Sinauer Associates Inc. ISBN-13: 978-1319121078.
3. Chemistry, 12 the Edition (2015). Raymond Chang, Kenneth A. Goldsby. McGraw-Hill Education. ISBN-13: 978-0078021510.

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (30%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (20%)** | | **Mid-1** | | **CLA-2 (25%)** | | **CLA-3 (25%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 40% | | | | 40% | | 40% | | 30% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 60% | | | | 40% | | 40% | | 45% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | 20% | | 20% | | 25% | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | | | **100%** | | **100%** | | **100%** | |

**Course Designers**

*a. Dr. Writoban Basu Ball, Dept. Of Biological Sciences. SRM University – AP*

# SEMESTER II

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

**Biochemistry-I: Biomolecules**

| Course Code | **BIO 101** | Course Category | | **DC** | L-T-P-C | 2 | **1** | **0** | 3 |
|---|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Equip students with a foundational understanding of bioenergetic principles and the structure-function relationships of key biomolecules. This knowledge is crucial for understanding metabolic pathways, cellular processes, and the molecular basis of life, forming a cornerstone for advanced studies in biological sciences.

2. Develop the ability to integrate knowledge of biomolecules such as carbohydrates, lipids, proteins, and nucleic acids into the context of cellular function and organismal biology. This integration is essential for comprehending complex biological systems and for pursuing specialized fields such as molecular biology, biochemistry, and physiology within a Biological Science BSc program.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe knowledge of biomolecules and bioenergetic principles. | 1 | 80% | 75% |
| **Outcome 2** | Classify carbohydrates, lipids, amino acids, and proteins with structure-function correlation. | 2 | 75% | 70% |
| **Outcome 3** | Describe the structure and functions of nucleic acids (DNA, RNA) and their different forms. | 1 | 80% | 75% |
| **Outcome 4** | Relate acquired knowledge to solve biochemical problems, critically analyze data, and communicate effectively in both written and oral formats. | 3 | 70% | 65% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Life long Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 2 | 1 | 2 | 1 | 1 | | 1 | 2 | 3 | | 2 | 2 | 1 | 3 |
| Outcome 2 | 3 | 3 | 2 | 3 | 2 | 2 | | 1 | 2 | 3 | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | | 2 | 2 | 3 | 3 |
| Outcome 4 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | | 3 | 3 | 3 | 3 |
| **Course Average** | **3** | **2.5** | **2** | **2.5** | **2** | **2.3** | **2** | **1.3** | **2.3** | **3** | | **2.3** | **2.5** | **2.3** | **3** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **1** | UNIT I: Bioenergetics | **12** | | |
| | Biomolecules: water- structure and properties, buffers, and their biological importance | 3 | 1,4 | **1,2,3** |
| | Principles of bioenergetics- laws of thermodynamics, entropy and enthalpy, standard free energy changes, | 3 | 1,4 | **1,2,3** |

| | | | | |
|---|---|---|---|---|
| | standard reduction potentials, | 4 | 1,4 | **1,2,3** |
| | thermodynamics of coupled reactions. | 2 | 1,4 | **1,2,3** |
| 2 | UNIT II: Carbohydrates | **12** | | |
| | Carbohydrates: definition and functions, | 4 | 2,4 | **1,2,3** |
| | classification, properties, monosaccharides, | 4 | 2,4 | **1,2,3** |
| | disaccharides, oligosaccharides, | 2 | 2,4 | **1,2,3** |
| | polysaccharides- homo- and hetero-polysaccharides. | 2 | 2,4 | **1,2,3** |
| 3 | UNIT III: Lipids | **12** | | |
| | Lipids: Classification, | 3 | 2,4 | **1,2,3** |
| | structure and properties, | 3 | 2,4 | **1,2,3** |
| | phospholipids, | 1.5 | 2,4 | **1,2,3** |
| | glycolipids, | 1.5 | 2,4 | **1,2,3** |
| | sphingolipids, | 1 | 2,4 | **1,2,3** |
| | cholesterol, | 1 | 2,4 | **1,2,3** |
| | fatty acids- saturated and unsaturated fatty acids. | 1 | 2,4 | **1,2,3** |
| 4 | UNIT IV: Amino acids and Proteins | **12** | | |
| | Amino Acids: Classification and properties, | 3 | 2,4 | **1,2,3** |
| | structure and properties of amino acids, | 2 | 2,4 | **1,2,3** |
| | essential and nonessential amino acids, | 3 | 2,4 | **1,2,3** |
| | proteins-classification and functions, | 1 | 2,4 | **1,2,3** |
| | levels of protein structure, | 2 | 2,4 | **1,2,3** |
| | haemoglobin,and myoglobin. | 1 | 2,4 | **1,2,3** |
| **5** | UNIT V: Nucleic Acids | **12** | 3,4 | |
| | Nucleic acids: Structure, | 3.5 | 3,4 | **1,2,3** |
| | purine and pyrimidine bases structure, | 3 | 3,4 | **1,2,3** |
| | properties and functions of nucleic acids (DNA, RNA) | 3 | 3,4 | **1,2,3** |
| | Different forms of DNA and RNA. | 2.5 | 3,4 | **1,2,3** |
| | Total | **60** | | |

**Recommended Resources**

**TEXTBOOKS**


1. Harper's Illustrated Biochemistry, V. W. Rodwell, D. Bender, K.M. Botham, P.J. Kennelly and P.A. Weil (2018) 31st edition, McGraw Hill-Medical.
2. Lehninger Principles of Biochemistry, D. L. Nelson and M. M. Cox, (2017) 7th edition, W.H. Freeman & Company.
3. Biochemistry: D. Voet and J.G. Voet (2011), 4th edition, Wiley.


**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (50%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | | **Mid-1 (15%)** | | **CLA-2 (10%)** | | **CLA-3 (15%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 80% | | 70% | | 70% | | 60% | | 50% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 20% | | 30% | | 30% | | 40% | | 50% | |
| | Analyse | | | | | | | | | | |
| | Evaluate | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Level 3 | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

*a. Prof. Jayaseelan Murugaiyan, Professor, Dept. Of Biological Sciences. SRM University – AP*

*b. Dr. Writoban Basu Ball, Dept. Of Biological Sciences. SRM University - AP*

*c. Dr. Sutharsan Govindrajan, Dept. Of Biological Sciences. SRM University - AP*

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

**Basic concepts in Microbiology**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BI0 102** | Course Category | **Core Course (CC)** | L-T-P-C | 2 | 1 | 0 | 3 |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Develop a foundational knowledge of microbial diversity, structure, and function, encompassing bacteria, archaea, and viruses. This understanding is essential for exploring the roles of microorganisms in various biological processes, ecosystems, and their impact on human health. It prepares students for advanced studies in microbial physiology, genetics, and ecology.

2. Equip students with theoretical and practical knowledge of microbiological methods, including sterilization, disinfection, culturing, and microbial taxonomy. These skills are critical for conducting research, diagnosing infectious diseases, and applying microbiological principles in industrial, clinical, and environmental settings. This objective emphasizes the practical applications of microbiology, aligning with the broader goals to produce proficient and versatile biologists.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the fundamental concepts and historical developments in microbiology. | 1 | 80% | 70% |
| **Outcome 2** | Interpret various methods for studying microbes and maintaining cultures, while assessing factors influencing microbial growth. | 2 | 75% | 65% |
| **Outcome 3** | Explain the processes of microbial genetic exchange and the basic structure and function of different microbial cells. | 1 | 80% | 70% |
| **Outcome 4** | Summarize the classification, structure, and pathogenic mechanisms of viruses and other molecular pathogens. | 2 | 75% | 65% |
| **Outcome 5** | Summarize the mechanisms of microbial diseases and the basic principles of antimicrobial agents, as well as their applications. | 2 | 75% | 65% |
| **Outcome 6** | Explain and perform the sterilization methods/protocols in microbiology to isolate microorganism, identify | 3 | 80% | 70% |

| | | | | |
|---|---|---|---|---|
| | strains by staining and perform growth kinetics of the same. | | | |

**Course Articulation Matrix (CLO) to (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | | | |
| Outcome 1 | 3 | 1 | 1 | 1 | 1 | | 3 | 3 | 1 | 2 | | 1 | 2 | 2 | 3 |
| Outcome 2 | 3 | 2 | 1 | 1 | 3 | 1 | 3 | 3 | 2 | 2 | | 2 | 2 | 3 | 3 |
| Outcome 3 | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 2 | | 2 | 3 | 1 | 2 |
| Outcome 4 | 3 | 1 | 1 | 2 | 2 | 1 | 3 | 3 | 2 | 3 | | 3 | 3 | 2 | 3 |
| Outcome 5 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | | 3 | 3 | 3 | 3 |
| Outcome 6 | 3 | 2 | 1 | 2 | 3 | | 3 | 2 | 3 | 3 | | | 3 | 3 | 3 |
| **Course Average** | **3** | **1.5** | **1.3** | **1.5** | **2.2** | **1.3** | **3** | **2.8** | **2** | **2.5** | | **2.2** | **2.6** | **2.3** | **2.8** |

**Course Unitization Plan - Theory**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| **Unit 1** | **Introduction to microbiology** | **8** | | |
| | History of microbiology | 2 | 1 | 1,2 |
| | Methods to study microbes. sterilization and disinfection; Growth media types - selective and differential media; Maintenance and preservation of bacterial cultures; Growth phases and kinetics, | 3 | 1 | 1,2 |

| | | | | |
|---|---|---|---|---|
| | influence of environmental factors for microbial growth | | | |
| | Cell division, transformation, transduction and conjugation. | 3 | 1 | 1,2 |
| **Unit 2** | **Microbial Cells - Types, Structure and Function** | **12** | | |
| | Classification and molecular taxonomy of microorganisms | 4 | 2 | 1,2 |
| | Ultrastructure of the archaea and bacterial cell | 4 | 2 | 1,2 |
| | Gram positive and gram-negative bacteria; Mycobacteria. | 4 | 2 | 1,2 |
| **Unit 3** | **Molecular pathogens** | **11** | | |
| | Viral structure and classification | 4 | 3 | 2,3 |
| | Bacteriophage and its life cycle | 3 | 3 | 2,3 |
| | Viral pathogenesis; Acute, chronic and latent viral infections; Viroid, prions, plasmids and transposable elements | 4 | 3 | 2,3 |
| **Unit 4** | **Microbial disease and antimicrobial agents** | **8** | | |
| | Microbial pathogens; Quorum sensing and biofilm | 4 | 4 | 2,3 |
| | Antimicrobials and Antibiotics: types, mechanism of action and resistance. | 4 | 4 | 2,3 |
| **Unit 5** | **Applied microbiology** | **6** | | |
| | Applications of microorganisms in industrial use; Food microbiology | 3 | 5 | 2,3 |
| | Environmental microbiology: Bioremediation, bioleaching, microbial degradation of textile waste. | 3 | 5 | 2,3 |
| **Unit 6** | **Experiments** | **30** | | |
| | Sterilization techniques- physical and chemical methods | 4 | 6 | 4,5 |
| | Preparation of media: Solid and Liquid media | 6 | 6 | 4,5 |
| | Isolation of microorganisms from different sources | 3 | 6 | 4,5 |
| | Staining methods: simple staining, Gram staining, negative staining and hanging drop. | 3 | 6 | 4,5 |
| | Enumeration of microorganism - total & viable count | 2 | 6 | 4,5 |
| | Microbial culture, growth curve and plating | 8 | 6 | 4,5 |
| | Preservation and maintenance of microbial cultures (slant, slab and cryo) | 4 | 6 | 4,5 |
| **Total Contact Hours** | | **75** | | |

**Recommended Resources**


1. Microbe, 3rd Edition (2022), Michele S. Swanson, Elizabeth A Joyce, Rachel Horak. ASM Press.
2. Prescotts Microbiology, 12th edition, Dorothy Wood , Joanne Willey, Kathleen Sandman.

McGraw Hill International.

3. A & P's Textbook of Microbiology, 12th Edition, R Ananthanarayan , CK Jayaram Paniker , Reba

Kanungo , Sonal Saxena. Universities Press.

4. Dubey RC, Maheshwari DK. Practical Microbiology, 4/e. S. Chand Publishing; 2002.
5. Sharma K. Manual of Microbiology. Ane Books Pvt Ltd; 2007


**Learning Assessment (Theory)**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | | | | | End Semester Exam (50%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | | Mid-1 (15%) | | CLA-2 (10%) | | CLA-3 (15%) | | | |
| | | Th | Prac | Th | Prac | Th | Prac | Th | Prac | Th | Prac |
| Level 1 | Remember | 80% | | 70% | | 70% | | 60% | | 50% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | | 20% | | 30% | | 30% | | 40% | | 50% |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**


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**SRM University – AP, Andhra Pradesh**

Neerukonda, Mangalagiri Mandal

Guntur District, Mangalagiri, Andhra Pradesh 522240

# Microbiology Lab

| Course Code | **BIO 103** | Course Category | **Core Course (CC)** | L-T-P-C | **0** | **0** | **2** | **2** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** To develop essential microbiological laboratory skills, including sterilization, media preparation, microbial isolation, staining, enumeration, culture maintenance, and preservation.

**Objective 2:** To cultivate critical thinking and analytical skills for designing experiments, interpreting results, and solving microbiological problems.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Demonstrate proficiency in sterilization and aseptic techniques. | 3 | 80% | 70% |
| **Outcome 2** | Prepare and utilize solid and liquid media for microbial cultures. | 3 | 80% | 70% |
| **Outcome 3** | Isolate, identify, and characterize microorganisms from various sources. | 4 | 80% | 70% |
| **Outcome 4** | Apply staining techniques to observe microbial morphology. | 4 | 75% | 65% |
| **Outcome 5** | Perform microbial enumeration, growth analysis, and culture preservation. | 4 | 75% | 70% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary | Analytical Reasoning and | Critical and Reflective | Scientific Reasoning and | Research Related Skills | Modern Tools and ICT | Environment and | Moral, Multicultural and | Individual and Teamwork | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong | PSO 1 | PSO 2 | PSO 3 |
| Outcome 1 | 3 | 3 | 3 | 3 | 3 | | | 2 | 3 | 1 | | 3 | 2 | 3 | 3 |
| Outcome 2 | 3 | 3 | 3 | 3 | 3 | | | | 2 | 1 | | 3 | 2 | 3 | 3 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | | | | 3 | 2 | | 3 | 3 | 3 | 3 |
| Outcome 4 | 3 | 3 | 3 | 3 | 3 | | | | 3 | 3 | | 3 | 2 | 3 | 3 |
| **Course Average** | **3** | **3** | **3** | **3** | **3** | | | **2** | **2.7** | **1.7** | | **3** | **2.2** | **3** | **3** |

**Course Unitization Plan – Lab**

| Exp No. | Experiment Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| 1. | Sterilization techniques- physical and chemical methods | 10 | 1 | 1,2 |
| 2. | Preparation of media: Solid and Liquid media | 5 | 2 | 1,2 |
| 3. | Isolation of microorganisms from different sources | 5 | 3 | 1,2 |
| 4. | Staining methods: simple staining, Gram staining, negative staining and hanging drop. | 10 | 4 | 1,2 |
| 5. | Enumeration of microorganism - total & viable count | 5 | 5 | 1,2 |

| | | | | |
|---|---|---|---|---|
| 6. | Microbial culture, growth curve and plating | 15 | 5 | 1,2 |
| 7. | Preservation and maintenance of microbial cultures (slant, slab and cryo) | 10 | 5 | 1,2 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources**

1. Harley & Prescott. Laboratory exercises in Microbiology.5th edition. 2002. The Mc-Graw Hill Companies
2. Practical Microbiology, A Manual, Dariel Burdass, John Grainger & Janet Hurst 2016

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | **End Semester Exam (50%)** |
|---|---|---|---|---|---|
| | | **Experiments (20%)** | **Record / Observation Note (10%)** | **Viva + Model (20%)** | |
| Level 1 | Remember | 50% | | 35% | 20% |
| | Understand | | | | |
| Level 2 | Apply | 50% | 100% | 65% | 80% |
| | Analyse | | | | |
| Level 3 | Evaluate | | | | |
| | Create | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** |

**Course Designers:**

Dr. Sudeshna Saha – Assistant Professor- Department of Biological Sciences -, SRM University -AP

# SEMESTER 3

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

**Metabolism of Biomolecules**

| Course Code | **BIO 201** | Course Category | | **DC** | L-T-P-C | **2** | **1** | **0** | **3** |
|---|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | **BIO 101** | Co-Requisite Course(s) | | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Understand fundamental metabolic concepts, including anabolism, catabolism, oxidation/reduction, and dehydration/hydrolysis.
2. Explore cellular respiration components, covering glycolysis, citric acid cycle, electron transport chain, oxidative phosphorylation, anaerobic respiration, and the Cori cycle.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Relate knowledge of metabolic concepts to analyze cellular processes and explain their interconnectedness. | 3 | 70% | 60% |
| **Outcome 2** | Summarize disorders related to lipid, amino acid, and nucleic acid metabolism. | 2 | 80% | 65% |
| **Outcome 3** | Demonstrate an understanding of regulatory mechanisms controlling metabolic pathways. | 3 | 70% | 60% |
| **Outcome 4** | Demonstrate the principles learned to comprehend the role of hormones and growth factors in metabolic regulation. | 3 | 70% | 60% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | | | | | 2 | 2 | 3 | 2 |
| Outcome 2 | 3 | 2 | 3 | 3 | 1 | 1 | | 2 | | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 3 | 3 | 3 | 2 | 1 | | | 1 | 2 | | 3 | 3 | 3 | 2 |
| Outcome 4 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 2 | | 3 | 3 | 2 | 3 |
| **Course Average** | **3** | **2.7** | **2.5** | **2.7** | **1.7** | **1** | **1.5** | **1.5** | **1** | **2** | **2** | **2.5** | **2.7** | **2.5** | **2.5** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **1** | UNIT I: Concepts of Metabolism and Carbohydrate Metabolism Anabolism and catabolism | **12** | | |
| | Metabolic reactions: oxidation/reduction, dehydration/hydrolysis, addition/subtraction/exchange, ligation | 2 | 1 | 1,2,3 |
| | The concept of cellular respiration: Glycolysis, citric acid cycle, electron transport chain and oxidative phosphorylation | 2 | 1 | 1,2,3 |
| | Anaerobic respiration and production of lactic acid | 2 | 1 | 1,2,3 |
| | Cori cycle | 1 | 1 | 1,2,3 |
| | Pentose phosphate pathway | 1 | 1 | 1,2,3 |
| | Gluconeogenesis | 1 | 1 | 1,2,3 |
| | Glycogen metabolism | 1 | 1 | 1,2,3 |
| | Role of hormones in sugar metabolism | 1 | 1,3 | 1,2,3 |
| | Brief introduction to metabolic disorders | 1 | 1,2 | 1,2,3 |
| **2** | UNIT II: Lipid Metabolism | **12** | | |
| | Lipid Metabolism- Lipolysis and β-oxidation | 2 | 1 | 1,2,3 |

| | | | | |
|---|---|---|---|---|
| | ketogenesis and causes of ketosis | 2 | 1 | 1,2,3 |
| | Lipogenesis | 2 | 1 | 1,2,3 |
| | Phospholipid biosynthesis | 2 | 1 | 1,2,3 |
| | Cholesterol biosynthesis and regulation | 2 | 1,3 | 1,2,3 |
| | Disorders of lipid metabolism. | 2 | 1,2 | 1,2,3 |
| **3** | UNIT III: Metabolism of Amino Acids and Proteins | **8** | | |
| | Amino acid metabolism | 2 | 1 | 1,2,3 |
| | Transamination | 1 | 1 | 1,2,3 |
| | Glucose-Alanine cycle | 1 | 1 | 1,2,3 |
| | Urea cycle and disorders | 1 | 1 | 1,2,3 |
| | Brief introduction to nitrogen cycle | 1 | 1 | 1,2,3 |
| | Biosynthesis of aromatic amino acids | 1 | 1 | 1,2,3 |
| | Inborn errors of amino acid metabolism. | 1 | 1,3 | 1,2,3 |
| **4** | UNIT IV: Metabolism of Nucleic acids | **4** | | |
| | Introduction to synthesis and degradation of nucleic acids- de novo and salvage pathway of purine and pyrimidine biosynthesis | 2 | 1 | 1,2,3 |
| | Catabolism of purines and pyrimidines | 2 | 1 | 1,2,3 |
| **5** | UNIT V: Intermediary metabolism | **9** | | |
| | Integration of carbohydrate, lipid and amino acid metabolism | 2 | 1 | 1,2,3 |
| | Basic concepts of metabolic regulation | 2 | 1,2 | 1,2,3 |
| | regulatory enzymes | 2 | 1 | 1,2,3 |
| | intrinsic control and allosteric regulation | 1 | 1 | 1,2,3 |
| | Hormone and growth factors controlling metabolism | 1 | 1,4 | 1,2,3 |
| | Brief introduction to xenobiotic metabolism. | 1 | 1 | 1,2,3 |
| | Total | **45** | | |

**Recommended Resources**

**TEXTBOOKS**


1. Harper's Illustrated Biochemistry, V. W. Rodwell, D. Bender, K.M. Botham, P.J. Kennelly and P.A. Weil (2018) 31st edition, McGraw Hill-Medical.
2. Lehninger Principles of Biochemistry, D. L. Nelson and M. M. Cox, (2017) 7th edition, W.H. Freeman & Company.
3. Biochemistry: D. Voet and J.G. Voet (2011), 4th edition, Wiley

**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | | | | | End Semester Exam (50%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | | Mid-1 (15%) | | CLA-2 (10%) | | CLA-3 (15%) | | | |
| | | Th | Prac | Th | Prac | Th | Prac | Th | Prac | Th | Prac |
| Level 1 | Remember | 80% | | 40% | | 40% | | 40% | | 60% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 20% | | 60% | | 60% | | 60% | | 40% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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**Cell Biology**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 202** | Course Category | **Core Course (CC)** | L-T-P/Pr-C | 3 | **1** | **0** | 4 |
| Pre-Requisite Course(s) | **BIO 101** | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Understand cell theory, origin of cells and about the different cellular forms of life.
2. Understand and learn the structure and functions of the different cell membranes and cellular organelles.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Explain cell theory, origin of cells and describe the properties of prokaryotes, eukaryotes and virus. | 2 | 70% | 65% |
| **Outcome 2** | Describe and differentiate the cell membranes and various cell organelles. | 3 | 70% | 65% |
| **Outcome 3** | Describe bacterial binary fission, eukaryotic cell division (cell cycle, mitosis, cytokinesis, meiosis), and cytoskeleton functions. | 3 | 70% | 65% |
| **Outcome 4** | Explain necrosis, senescence, apoptosis and oncogenes. | 2 | 70% | 65% |
| **Outcome 5** | Describe stem cells | 2 | 80% | 70% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 1 | | 1 | | | | | | | | 2 | 2 | 3 | 2 |
| Outcome 2 | 3 | 1 | | 1 | | | | | | | | 2 | 2 | 3 | 2 |
| Outcome 3 | 3 | 1 | 1 | 1 | 1 | | | | 1 | | | 3 | 2 | 3 | 2 |
| Outcome 4 | 3 | 2 | 2 | 2 | 1 | | | | 1 | | | 2 | 3 | 3 | 3 |
| Outcome 5 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | | | | 3 | 3 | 3 | 3 |
| **Course Average** | **3** | **1.6** | **2** | **1.6** | **1.7** | **2** | **3** | **2** | **1.7** | | | **2.4** | **2.4** | **3** | **2.4** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| **Unit 1** | **Introduction to Cell biology** | **15** | | |
| | History of Cell biology | 1 | 1 | 1, 2, 3 |
| | Cell theory; Origin and Evolution of cells | 5 | 1 | 1, 2, 3 |
| | Basic properties of cells; Prokaryotic cells and types (bacteria and archaea) | 3 | 1 | 1, 2, 3 |
| | Eukaryotic cells and types (unicellular and multicellular eukaryotes) | 3 | 1 | 1, 2, 3 |

| | | | | |
|---|---|---|---|---|
| | Cellular organization of prokaryotes vs eukaryotes | 3 | 1 | 1, 2, 3 |
| **Unit 2** | **Cell structure and function** | **9** | | |
| | Animal, plant and yeast cells | 2 | 2 | 1, 2, 3 |
| | Cell Membrane architecture, and models of membrane structure and function | 2 | 2 | 1, 2, 3 |
| | Cytoskeleton | 3 | 2 | 1, 2, 3 |
| | Transport across membranes: Passive and Active transport | 2 | 2 | 1, 2, 3 |
| **Unit 3** | **Structure and Function of Cellular Organelles** | **12** | | |
| | Nucleus, Nucleo-cytoplasmic transport | 1.5 | 2 | 1, 2, 3 |
| | endoplasmic reticulum, Golgi apparatus, lysosomes, Protein import into ER and Golgi | 1.5 | 2 | 1, 2, 3 |
| | Mitochondria – structure and origin, Protein import into mitochondria | 1.5 | 2 | 1, 2, 3 |
| | Chloroplast – structure and origin | 1 | 2 | 1, 2, 3 |
| | Vacuoles, peroxisomes, glyoxysomes | 1.5 | 2 | 1, 2, 3 |
| | Membraneless organelles: ribosomes, nucleolus, stress granules | 2.5 | 2 | 1, 2, 3 |
| | Exocytosis and Endocytosis | 2.5 | | |
| **Unit 4** | **Cell division** | **9** | | |
| | Cell division in bacteria: Binary fission | 2 | 3 | 1, 2, 3 |
| | Eukaryotic cell division: Cell cycle and regulation | 5 | 3 | 1, 2, 3 |
| | Meiosis | 2 | 3 | 1, 2, 3 |
| **Unit 5** | **Cell death** | **8** | | |
| | Necrosis | 2 | 4 | 1, 2, 3 |
| | Senescence | 2 | 4 | 1, 2, 3 |
| | Apoptosis, Programmed cell death and their mechanisms. | 4 | 4 | 1, 2, 3 |
| **Unit 6** | **Stem Cell Biology** | **7** | | |
| | Introduction to stem cell biology | 2 | 5 | 1, 2, 3 |
| | Stem cell potency and control | 3 | 5 | 1, 2, 3 |
| | Human embryonic stem cells | 2 | 5 | 1, 2, 3 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources**


1. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, Molecular Cell Biology, W. H. Freeman; 6th edition, 2007.
2. Bruce Alberts, Molecular Biology of the Cell, Garland Science, 5th edition, 2008
3. Cooper, G. M., & Hausman, R. E. (2004). The cell: Molecular approach. Medicinska naklada.

**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | | | | | End Semester Exam (50%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | | Mid-1 (15%) | | CLA-2 (10%) | | CLA-3 (15%) | | | |
| | | Th | Prac | Th | Prac | Th | Prac | Th | Prac | Th | Prac |
| Level 1 | Remember | 70% | | 70% | | 70% | | 70% | | 70% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 30% | | 30% | | 30% | | 30% | | 30% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

**Concepts of Genetics**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 203** | Course Category | **Core Course (CC)** | L-T-P-C | **3** | **1** | **0** | **4** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Explain the fundamental principles of genetics, including inheritance patterns, gene structure, and function.
2. Apply genetic techniques such as Punnett squares, pedigree analysis, and molecular tools to solve problems and analyze genetic data.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe key genetic concepts, including pre-Mendelian ideas and Mendel's principles | 2 | 80% | 75% |
| **Outcome 2** | Explain the molecular basis of mutations, distinguishing between induced and spontaneous mutations | 2 | 80% | 75% |
| **Outcome 3** | Compare and contrast bacterial genetics, bacterial transposons, horizontal and vertical gene transfer, and principles of phage genetics | 4 | 60% | 60% |
| **Outcome 4** | Apply advanced chromosomal techniques, such as FISH, karyotyping, SKY, and chromosome painting | 3 | 70% | 65% |
| **Outcome 5** | Assess the impact of natural selection and genetic drift in population genetics. | 5 | 60% | 60% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| | **Program Learning Outcomes (PLO)** |
|---|---|

| CLOs | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Life long Learning | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 2 | 2 | 3 | 1 | 1 | 2 | | 2 | | | 2 | 3 | 2 | 2 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | 1 | | | 1 | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 2 | 1 | | | 2 | 3 | 3 | 3 |
| Outcome 4 | 3 | 3 | 3 | 3 | 3 | 1 | | 2 | 2 | | | 2 | 3 | 3 | 2 |
| Outcome 5 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | | 3 | 3 | 2 | 3 |
| **Course Average** | **3** | **2.2** | **2.6** | **2.8** | **2.4** | **1.4** | **2.3** | **2** | **1.6** | **1** | | **2.2** | **3** | **2.4** | **2.6** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Unit 1** | **Introduction to genetics** | **12** | | |
| | Introduction to genetics and historical context.<br>Scope of genetics. | 2 | 1 | 1,2,3 |
| | **Pre-Mendelian Genetics:**<br>Key concepts and developments. | 2 | 1 | 1,3 |
| | **Mendel's Work:**<br>Principles and experiments. | 2 | 1 | 1,3 |
| | **Genetic Variation:**<br>Barbara McClintock's contributions.<br>Non-Mendelian genetics. | 2 | 1 | 1,3 |
| | **Principles of Inheritance**:<br>Principles and applications. | 2 | 1 | 1,3 |
| | **Alleles and Inheritance Mechanisms:**<br>Concept and basics of alleles.<br>Multiple alleles, lethal alleles, linkage, and crossing over. | 2 | 1 | 1,3 |
| **Unit 2** | **Mutations** | **12** | | |
| | **Chromosomal Mutations:**<br>Overview and types. | 2 | 2 | 1,2,3 |
| | **Gene Mutations:**<br>Types and distinctions. | 2 | 2 | 1,2,3 |
| | **Molecular Basis of Mutations:**<br>Relation to UV light and chemical mutagens. | 2 | 2 | 1,2,3 |
| | **Mutations Comparison:**<br>Comparative analysis. | 2 | 2 | |
| | **Induced vs. Spontaneous Mutations:**<br>Differences and significance. | 2 | 2 | |
| | **Back vs. Suppressor Mutations:**<br>Analysis and implications. | 2 | 2 | 1,2,3 |
| **Unit 3** | **Bacterial and phage genetics** | **12** | | |
| | **Phage Genetics:**<br>Overview and applications. | 2 | 3 | 1, 2 |
| | **Fine Structure of Gene in Bacteriophage T4:** | 2 | 3 | |

| | | | | |
|---|---|---|---|---|
| | Benzer's fine structure, plaque formation, and mapping. | | | |
| | **Bacterial Genetics:** Genetics of bacteria. | 2 | 3 | |
| | **Gene Transfer in Bacteria:** Bacterial transposons, vertical and horizontal gene transfer. | 2 | 3 | 1, 2 |
| | **Bacterial Transformation:** Mechanisms and applications. | 2 | 3 | 1, 2 |
| | **Bacterial Conjugation:** Understanding the process. | 2 | 3 | 1, 2 |
| **Unit 4** | **Chromosomal basis of inheritance** | **12** | | |
| | **Chromosome Structure:** Basics and implications. | 2 | 4 | 1,2,4 |
| | **Cytogenetics:** Techniques and applications. | 2 | 4 | 1,2,3,4 |
| | **Chromosomal Staining and Banding Patterns:** Techniques and interpretation. | 2 | 4 | 1,2,3,4 |
| | **Fluorescent in-situ Hybridizations (FISH):** Principles and applications. | 2 | 4 | 1,2,3,4 |
| | **Advanced Chromosome Biology:**<br>• Karyotyping and Spectral Karyotyping (SKY). | 2 | 4 | 1,2,3,4 |
| | **Chromosome Painting:** Significance and applications. | 2 | 4 | 1,2,3,4 |
| **Unit 5** | **Population genetics and model organism** | **12** | | |
| | **Allele and Genotype Frequencies:** Understanding and calculations. | 2 | 1,5 | 1,2,3,4 |
| | **Hardy-Weinberg Law:** Principles and applications. | 2 | | |
| | **Natural Selection:** Role in population genetics. | 2 | 1,5 | 1,2,3,4 |
| | **Genetic Drift:** Understanding its impact. | 2 | 1,5 | 1,2,3,4 |

| | | | | |
|---|---|---|---|---|
| | **Speciation:** Principles and examples. | 2 | 1,5 | 1,2,3,4 |
| | **Pedigree Analysis and Model Organisms:** Techniques and introduction to model organisms. | 2 | 1,5 | 1,2,3,4 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources**

1. Introduction to Genetic Analysis: A.J. Griffiths et al. (2008) 9 edition, W.H. Freeman.
2. iGenetics: A Molecular Approach by Peter J Russell, 3rd edition, Pearson International Edition.
3. Genetics: A Conceptual Approach by Benjamin A Pierce, 5th edition. W.H. Freeman.
4. Concepts of Genetics by Klug, Cummings, Spencer, Palladino, 11th edition. Pearson.

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (50%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | | **Mid-1 (15%)** | | **CLA-2 (10%)** | | **Mid-2 (15%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 45% | | 50% | | 40% | | 50% | | 30% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 50% | | 45% | | 40% | | 30% | | 50% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | 5% | | 5% | | 20% | | 20% | | 20% | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

*a. Dr. Writoban Basu Ball, Assistant Professor, Dept. Of Biological Sciences. SRM University – AP*

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
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**Evolutionary Biology**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 204** | Course Category | **Core Course (CC)** | L-T-P-C | **3** | **1** | **0** | **4** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. To understand and explore the methods involved in gauging diversification of life and adapt phylogenetic analysis in deciphering the complexities of biological evolution and its directions.
2. To understand the evolution of humans and explore the same in the perspective of diseases.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Define the origin and diversity of life and its evolution | 1 | 70% | 60% |

| | | | | |
|---|---|---|---|---|
| **Outcome 2** | Summarize the principles of evolution, its properties and intricacies involved. | 2 | 65% | 60% |
| **Outcome 3** | Relate the direction of evolution and methods involved in exploring the evolutionary mechanisms | 3 | 65% | 55% |
| **Outcome 4** | Articulate the evolution of humans and underpin the reasons for variations and diseases | 3 | 65% | 55% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | | | | 2 | 2 | 3 | 2 |
| Outcome 2 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | | | | 3 | 2 | 3 | 3 |
| Outcome 3 | 3 | 3 | 2 | 3 | 1 | 3 | 1 | 2 | 1 | 2 | | 2 | 3 | 3 | 1 |
| Outcome 4 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | | 3 | 3 | 2 | 3 |
| **Course Average** | **3** | **2.5** | **1.8** | **2.5** | **1.5** | **2** | **1.3** | **2.5** | **1.5** | **2.5** | | **2.5** | **2.5** | **2.8** | **2.3** |

| **Unit No.** | **Unit Name** | **Required Contact Hours** | **CLOs Addressed** | **References** |
|---|---|---|---|---|
| **Unit 1** | **Origin of Life and Evolution** | **12** | | |
| | Concept of evolution; Importance and potential applications of evolution in real life; | 3 | 1 | 1, 2 |

| | | | | |
|---|---|---|---|---|
| | Origin of Life: Fitness and Darwin's theory; | 3 | 1, 2 | 1, 2 |
| | Selection: Artificial, natural and sexual; Mutations and their role in evolution; | 4 | 1, 2 | 1, 2 |
| | Introduction to phenotype and genotype | 2 | 1 | 1, 2 |
| **Unit 2** | **Species and Speciation** | **12** | | |
| | Concept of species; Causes of speciation and properties of species | 3 | 1, 2 | 1, 2 |
| | Asexual speciation; Orthologs, paralogs, homologs; | 3 | 1, 2 | 1, 2 |
| | Methods of classification; | 3 | 1, 2 | 1, 2 |
| | Ancestral lineage; Inheritance | 3 | 2, 3 | 1, 2, 3 |
| **Unit 3** | **Phylogeny** | **12** | | |
| | Gene Genealogy: gene Tree, species tree, gene transfer, xenology; | 3 | 1,3,4 | 4, 5 |
| | Phylogenetic trees: basic concepts of trees: Rooted and un-rooted trees; | 3 | 1,3,4 | 4, 5 |
| | Networks and their biological nature; | 3 | 1,3,4 | 4, 5 |
| | The concept of phyla: monphylatic, polyphylatic and paraphylatic groups. | 3 | 1,3,4 | 4, 5 |
| **Unit 4** | **Direction of evolution** | **12** | | |
| | Evolutionary rate and distances; Units of evolution, evolutionary and adaptive landscapes; | 3 | 1, 4 | 3, 4, 5 |
| | Convergent, Parallel and Divergent evolutions; | 3 | 1, 4 | 3, 4, 5 |
| | Coevolution; Adaptive diversification of coevolutionary systems; | 3 | 1, 4 | 3, 4, 5 |
| | Role of microbiome and parasites in evolution of hosts; Living fossils and extinction. | 3 | 1, 4 | 3, 4, 5 |
| **Unit 5** | **Human Evolution** | **12** | | |
| | Theories of human evolution | 3 | 1, 2, 4 | 5, 6 |
| | Phenotypic and genotypic variations; | 3 | 1, 2, 4 | 5, 6 |
| | Classic markers and DNA markers in human variation; | 3 | 1, 2, 4 | 5, 6 |
| | Evolution of human growth; Diseases in evolutionary perspective. | 3 | 1, 2, 4 | 5, 6, 7 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources**


1. The Evolutionary Biology of Species (2019) by Timothy G. Barraclough, Oxford University Press.
2. Introduction to Evolutionary Genomics 2nd edition (2018) by Naruya Saitou, Springer publishers
3. Phylogenetic Trees Made Easy 5th edition (2018), Barry G. Hall. Oxford University Press.
4. Human evolutionary biology (2010) Michael P. Meuhlenbein, Cambridge University Press.
5. Evolutionary Analysis: S. Freeman and J.C. Herron. Prentice Hall

6. Evolution: D.J. Futuyma. Sinauer Associates
7. Ecology: from individuals to ecosystems: M. Begon, C.R. Townsend, Blackwell Publishing

**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | End Semester Exam (50%) |
|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | Mid-1 (15%) | CLA-2 (10%) | Mid-2 (15%) | |
| | | Th | Th | Th | Th | Th |
| Level 1 | Remember | 40% | 60% | 40% | 60% | 30% |
| | Understand | | | | | |
| Level 2 | Apply | 60% | 40% | 60% | 40% | 70% |
| | Analyse | | | | | |
| Level 3 | Evaluate | | | | | |
| | Create | | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** | **100%** |

**Course Designers**

1. *Dr. Naga Bhushana Rao Karampudi, Assistant Professor, Department of Biological Sciences, SRM University – AP.*
2. *Dr. Writoban Basu Ball, Assistant Professor, Department of Biological Sciences, SRM University – AP.*

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

**Biochemistry Lab**

| Course Code | **BIO 208** | Course Category | **Core Course (CC)** | L-T-P-C | **0** | **0** | **2** | **2** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Students will acquire hands-on experience in preparing buffers, performing quantitative analyses of various biological molecules (such as carbohydrates, proteins, and nucleic acids), and utilizing separation techniques like thin-layer chromatography (TLC) and

paper chromatography. This objective emphasizes the practical application of biochemical methods in lab settings.

2. Students will learn to determine enzyme activity and investigate the factors that influence enzymatic reactions, with a specific focus on salivary amylase. They will develop the ability to design experiments, interpret results, and understand the underlying principles governing enzyme kinetics and functionality.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe and explain the principles of preparing buffers and the methodologies for the quantitative analysis of carbohydrates, proteins, and nucleic acids. | 2 | 80% | 70% |
| **Outcome 2** | Analyze and interpret chromatograms to identify and quantify components of amino acid mixtures and leaf pigments. | 4 | 80% | 70% |
| **Outcome 3** | Evaluate the factors influencing enzyme activity and design controlled experiments to measure the activity of salivary amylase under different conditions. | 5 | 80% | 70% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 3 | 1 | | 2 | 2 | 3 | 2 |
| Outcome 2 | 3 | 3 | 3 | 3 | 3 | 1 | | 2 | 2 | | | 2 | 2 | 3 | 3 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | 1 | | 1 | 3 | 3 | | 3 | 3 | 3 | 3 |
| **Course Average** | **3** | **3** | **3** | **3** | **3** | **1** | **1** | **1.3** | **2.3** | **2** | | **2.3** | **2.3** | **3** | **2.6** |

**Course Unitization Plan – Lab**

| Exp No. | Experiment Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| 1. | Preparation of Buffers | 8 | 1 | 1 |
| 2. | Quantitative analysis of carbohydrates. | 8 | 1 | 1 |
| 3. | Quantitative estimation of Proteins. | 8 | 1 | 1 |
| 4. | Quantitative estimation of Nucleic Acids. | 6 | 1 | 1 |
| 5. | Separation of amino acids by TLC. | 6 | 2 | 1 |
| 6. | Separation of leaf pigments by paper chromatography. | 6 | 2 | 1 |
| 7. | Determination of enzyme activity of salivary amylase. | 8 | 3 | 1 |
| 8. | Factors influencing enzyme activity. | 10 | 3 | 1 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources:**

1. Essentials of Practical Biochemistry. (2017) Prem Prakash Gupta. Jaypee Brothers Medical Publishers.1st Edition. (ISBN: 9386056909)

**Learning Assessment**

| | **Continuous Learning Assessments (50%)** | |
|---|---|---|

| Bloom's Level of Cognitive Task | | Experiments (20%) | Record / Observation Note (10%) | Viva + Model (20%) | End Semester Exam (50%) |
|---|---|---|---|---|---|
| Level 1 | Remember | 50% | | 25% | 25% |
| | Understand | | | | |
| Level 2 | Apply | 50% | 100% | 65% | 60% |
| | Analyse | | | | |
| Level 3 | Evaluate | | | 10% | 15% |
| | Create | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** |

**Course Designers:**

Prof. Jayaseelan Murugaiyan, Professor- Department of Biological Sciences, SRM University Andhra Pradesh

# SEMESTER 4

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

**Concepts in Molecular Biology**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 205** | Course Category | **Core Course (CC)** | L-T-P-C | **2** | **1** | **0** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |

| | | | |
|---|---|---|---|
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Describe the structure and function of key biomolecules, including nucleic acids, proteins, and lipids, and their roles in cellular processes.
2. Apply molecular biology techniques such as PCR, gel electrophoresis, and recombinant DNA technology to analyze and manipulate genetic material.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the intricacies of gene transcription and the intricate realm of RNA processing. | 2 | 80% | 75% |
| **Outcome 2** | Describe the intricate landscape of post-transcriptional processing and the diverse realm of modifications that shape cellular processes. | 2 | 80% | 70% |
| **Outcome 3** | Explain genetic code to protein synthesis machinery. | 2 | 80% | 70% |
| **Outcome 4** | Explain chromatin dynamics and multilayered gene regulation. | 2 | 70% | 65% |
| **Outcome 5** | Describe the molecular mechanisms underlying repair of DNA. | 2 | 70% | 65% |

| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solvi | Critical and Reflective Thinking | Scientific Reasoning and Design Thinki | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learni | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ng | | ng | | | | | | | | ng | | | |
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | | 2 | 3 | 1 | 2 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | | 1 | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | | 1 | | | 2 | 3 | 3 | 3 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | | 1 | | | 2 | 3 | 3 | 2 |
| Outcome 5 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | | 2 | | | 3 | 3 | 2 | 3 |
| **Course Average** | **3** | **2** | **3** | **3** | **2.4** | **1.4** | **2.8** | **3** | **1.6** | **3** | | **2.2** | **3** | **2.2** | **2.6** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **Gene Expression: Transcription and RNA Processing** | **10** | | |
| | RNA world; Origin of DNA and classical experiments proving DNA as genetic material | 1 | 1 | 1,3,4 |
| | Complexity of definition of a gene, | 1 | 1 | 1,2,3 |
| | Prokaryotic and eukaryotic gene structure; | 1 | 1 | 1,2,3 |
| | Types of genes; Prokaryotic and eukaryotic promoters, | 1 | 1 | 3,4 |
| | Mechanism of transcription | 2 | 1 | 3,4 |
| | Types of RNAs | 1 | 1 | 1,2,4 |
| | prokaryotes and eukaryotes structure of rRNA, | 1 | 1 | 1,2,4 |

| | | | | |
|---|---|---|---|---|
| | prokaryotes and eukaryotes structure of tRNA, | 1 | 1 | 1,2,4 |
| | prokaryotes and eukaryotes structure of mRNA | 1 | 1 | 1,2,4 |
| **Unit 2** | **Gene Expression: Post-Transcriptional Processing and Modifications** | **8** | | |
| | Processing ribosomal RNAs | 1 | 1 | 1,2,3 |
| | biogenesis and assembly of ribosomal subunits in the nucleolus; | 2 | 1 | 1,2,3 |
| | tRNA processing and modifications | 2 | 2 | 1,2,4 |
| | mRNA-splicing, | 1 | 2 | 1,2,4 |
| | mRNA- modification; | 1 | 2 | 1,2,4 |
| | RNA transport | 1 | 2 | 1,2,4 |
| **Unit 3** | **Gene Expression: Translation and Post-Translational Modifications** | **8** | | |
| | Genetic code, degeneracy and codon bias. | 1 | 3 | 1,2,3 |
| | Ribosome; Structure and Function of the protein synthesis machinery: | 2 | 3 | 1,2,3 |
| | The Ribozyme; Prokaryotic translation: | 1 | 3 | 1,2,3 |
| | coupled transcription and translation; | 1 | 3 | 1,2,3 |
| | Eukaryotic translation: translational factors, steps in translation: | 2 | 3 | 1,2,3 |
| | Initiation, elongation and termination; Post-translational modification of proteins and protein transport. | 1 | 3 | 1,2,3 |
| **Unit 4** | **Gene Regulation** | **9** | | |
| | Chromatin structure and function; Gene regulation at multiple levels; | 2 | 4 | 2,4 |
| | Transcriptional regulation: activators and repressors, | 2 | 4 | 2,4 |
| | Transcriptional factors and basic transcriptional machinery in eukaryotes; | 1 | 4 | 2,4 |
| | Post-transcriptional regulation of gene expression, Translational & post-translational regulation of gene expression; | 1 | 4 | 2,4 |
| | Regulation of gene expression in prokaryotes using lac operon as a model. | 3 | 4 | 2,4 |
| **Unit 5** | **DNA Replication and Repair** | **10** | | |
| | Meselson and Stahl experiment: Semi-conservative nature of DNA replication. | 2 | 5 | 2,3 |
| | The mechanism of DNA replication: | 2 | 5 | 2,3 |
| | Replication fork, leading and lagging strands, enzymes and proteins involved in replication; | 2 | 5 | 2,3 |
| | The replication process: Initiation, elongation and termination, | 1 | 5 | 2,3 |

| | | | | |
|---|---|---|---|---|
| | Proof reading; Replication in prokaryotes and eukaryotes, | 1 | 5 | 2,3 |
| | DNA damage and repair mechanisms, | 1 | 5 | 2,3 |
| | Recombination and repair mechanisms, SOS system | 1 | 5 | 2,3 |
| **Total Contact Hours** | | **45** | | |

**Recommended Resources**


1. Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter
   2014. 6 th edition, Garland Science.

2. Genes VIII. Benjamin Lewin. 8th edition, Pearson.

3. Molecular Biology of the Gene: J.D. Watson, T.A. Baker, S.P. Bell, A.A.F. Gann, M. Levine and
   R.M. Losick (2007). 7th edition. Benjamin Cummings.

4. Molecular Cell Biology: H. Lodish, A. Berk, C.A. Kaiser et al (2007) 6th edition. W.H. Freeman.


**Learning Assessment (Theory)**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (50%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | | **Mid-1 (15%)** | | **CLA-2 (15%)** | | **CLA-3 (10%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 100 % | | 100 % | | 100 % | 100 % | 100 % | 100 % | 100 % | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | | | | | | | | | | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**


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**Experimental Methods of Biology**

| Course Code | **BIO 206** | Course Category | **Core Course (CC)** | L-T-P-C | **3** | **1** | **0** | **4** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

**Objective 1:** Gain a thorough knowledge of the principles underlying various microscopy and centrifugation techniques.

**Objective 2:** Comprehend the principles of various separation and quantification techniques which have application in structural biology and biophysics.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Recall key experimental approaches and model organisms, including the principles of flow cytometry, centrifugation, chromatography, electrophoresis, spectroscopy, and microscopy. | 1 | 70% | 65% |
| **Outcome 2** | Explain the underlying principles and applications of techniques such as centrifugation, chromatography, and electrophoresis. | 2 | 70% | 65% |
| **Outcome 3** | Apply experimental techniques like flow cytometry, differential centrifugation, HPLC, and various types of microscopy to analyze biological samples. | 3 | 70% | 65% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Pr | Critical and Reflective Think | Scientific Reasoning and De | Research Related Skills | Modern Tools and ICT Usa | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Ski | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifel | PSO1 | PSO2 | PSO3 |

| | | o b le m S o l v i n g | i n g | si g n T h i n k i n g | | g e | | | ll s | | | o n g L e a r n i n g | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | | 3 | 2 | | 2 | 3 | 1 | 3 |
| Outcome 2 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | | 1 | 2 | | 2 | 3 | 3 | 2 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | | 1 | 2 | | 2 | 3 | 3 | 3 |
| **Course Average** | **3** | **3** | **3** | **3** | **2.3** | **1.3** | **1** | | **1.6** | **2** | | **2** | **3** | **2.3** | **2.6** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **Introduction to Experimental approaches and Model Organisms** | **10** | | |
| | Choice of samples- organism, tissue, biological fluids, cells, and cellular organisms. | 2 | 1 | 1 |
| | Whole cell analysis -flow cytometry | 5 | 1 | 1 |
| | Choice of model organisms for biological investigations: microorganisms, plants, and animal models | 3 | 1 | 1 |
| **Unit 2** | **Centrifugation** | **10** | | |
| | Principles of Centrifugation | 2 | 2 | 1,2 |
| | Sedimentation | 2 | 2 | 1,2 |
| | Types of rotors | 2 | 2 | 1,2 |
| | Preparative and analytical centrifuges | 2 | 2 | 1,2 |
| | Methods: Differential, Zonal and Density gradient. | 2 | 2 | 1,2 |
| **Unit 3** | **Chromatography Techniques** | **10** | | |
| | Principles of Chromatography | 2 | 2 | 2,4 |
| | Paper, TLC | 2 | 2 | 2,4 |

| | | | | |
|---|---|---|---|---|
| | Gel filtration, Ion exchange, Affinity | 2 | 2 | 2,4 |
| | Gas-Liquid Chromatography | 2 | 2 | 2,4 |
| | High performance Liquid Chromatography (HPLC) | 2 | 2 | 2,4 |
| **Unit 4** | **Electrophoretic and Immunological Techniques** | **10** | | |
| | Principles and applications of electrophoresis | 2 | 2 | 2,3,4 |
| | Poly-Acrylamide Gel Electrophoresis (PAGE); Agarose gel electrophoresis | 1 | 2 | 2,3,4 |
| | Two dimensional (2D) electrophoresis; Iso-electric focusing | 1 | 2 | 2,3,4 |
| | Immunodiffusion, Immunoelectrophoresis | 1 | 2 | 2,3,4 |
| | ELISA, and Radio-Immune Assay (RIA) | 2 | 2 | 2,3,4 |
| | Blotting techniques: Southern, Northern and Western | 2 | 2 | 2,3,4 |
| | Immunohistochemistry | 1 | 2 | 2,3,4 |
| **Unit 5** | **Spectroscopic Techniques** | **10** | | |
| | Principles of spectroscopy and its applications in biological research | 2 | 3 | 2 |
| | Theory and Application of UV and Visible Spectroscopy | 2 | 3 | 2 |
| | Fluorescence Spectroscopy | 2 | 3 | 2 |
| | Atomic Absorption Spectroscopy (AAS) | 2 | 3 | 2 |
| | Mass Spectrometry (MS) | 2 | 3 | 2 |
| **Unit 6** | **Microscopy** | **10** | | |
| | Principles of microscopy | 3 | 3 | 5 |
| | Light, Fluorescence, Confocal, and Super-resolution microscopy | 3 | 3 | 5 |
| | Fluorochromes and their applications | 2 | 3 | 5 |
| | Transmission and Scanning electron microscopy and sample preparation for light and electron microscopy. | 2 | 3 | 5 |
| Total Contact Hours | | **60** | | |

**Recommended Resources**


1. Wilson and Walker's principles and techniques of biochemistry and molecular biology. 2018.
   Hofmann, A., & Clokie, S. (Eds.). Cambridge University Press. 8th edition
2. Biophysics and Bioinstrumentation. 2015. N Arumugam, V Kumaresan. Saras Publications
3. Bioinstrumentation. 2018. Reilly N J. CBS
4. Biochemical Techniques and Instrumentation. 2020. S Felix F Parthiban. Daya Publishing House
5. Fundamentals of Light Microscopy and Digital Imaging. (2012). Murphy DB, Wiley-Liss, New York.


**Learning Assessment**

| **Bloom's Level of Cognitive Task** | **Continuous Learning Assessments (50%)** | | | | **End Semester** |
|---|---|---|---|---|---|
| | **CLA-1 (10%)** | **Mid-1 (15%)** | **CLA-2 (10%)** | **Mid-2 (15%)** | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | **Exam (50%)** | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 80% | | 70% | | 80% | | 70% | | 60% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 20% | | 30% | | 20% | | 30% | | 40% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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Neerukonda, Mangalagiri Mandal
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**Introductory Biophysics**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 207** | Course Category | **Core Course (CC)** | L-T-P-C | **2** | **1** | **0** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Grasp fundamental concepts of thermodynamics, including energy conservation, entropy, Gibbs free energy, and equilibrium constants, and how these principles apply to living systems.
2. Explore the dynamics of biomolecules, protein structure and folding, and the role of intrinsically disordered proteins, along with techniques such as circular dichroism and X-ray crystallography for structural resolution.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe how energy conservation, entropy, enthalpy, and Gibbs free energy apply to biological systems. | 2 | 80% | 75% |
| **Outcome 2** | Explain the principles of diffusion, Brownian motion, and osmosis and their relevance to biomolecular transport. | 2 | 80% | 70% |
| **Outcome 3** | Analyze the factors influencing protein folding, stability, denaturation, and renaturation, using hemoglobin as a model. | 4 | 70% | 60% |
| **Outcome 4** | Discuss the sequence, structural features, and molecular interactions of IDPs and IDRs, highlighting examples like NFkB. | 2 | 80% | 70% |
| **Outcome 5** | Apply structural resolution techniques such as circular dichroism and X-ray crystallography to study protein-ligand interactions. | 3 | 70% | 65% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| | **Program Learning Outcomes (PLO)** |
|---|---|

| CLOs | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | 1 | 2 | 3 | 3 | 3 | | 2 | 3 | 1 | 2 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | 1 | | | 1 | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 2 | 3 | 3 | 3 | 1 | | | 1 | | | 2 | 3 | 3 | 3 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 1 | | | 1 | | | 2 | 3 | 2 | 3 |
| Outcome 5 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | | 2 | | | 3 | 3 | 3 | 2 |
| **Course Average** | **3** | **2** | **3** | **3** | **2.4** | **1.4** | **2** | **3** | **1.6** | **3** | | **2.2** | **3** | **2.2** | **2.6** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **Thermodynamics of Living System** | **9** | | |
| | Conservation of energy in living systems | 1.5 | 1 | 1,2,3 |
| | Entropy and Enthalpy | 1.5 | 1 | 1,2,3 |
| | Gibbs and Standard free energy | 1.5 | 1 | 1,2,3 |
| | Equilibrium constant | 1.5 | 1 | 1,2,3 |
| | Coupled reactions | 1.5 | 1 | 1,2,3 |
| | Molecular forces and Bioenergetics | 1.5 | | |
| **Unit 2** | **Dynamics of Biomolecules** | **9** | | |
| | Chirality of biomolecules | 2 | 2 | 1,2,3 |
| | Diffusion: Laws | 2 | 2 | 1,2,3 |
| | Brownian motion | 2 | 2 | 1,2,3 |
| | Active and Passive transport | 2 | 2 | 1,2,3 |
| | Osmosis: Osmotic pressure, Osmoregulation | 1 | 2 | 1,2,3 |
| **Unit 3** | **Protein structure and Folding** | **9** | | |
| | Behavior of proteins in solution, Protein folding, Forces of protein stability | 2 | 3 | 1,2,3 |
| | Protein denaturation and renaturation | 2 | 3 | 1,2,3 |
| | Hemoglobin: structure, function, oxygen binding, Hill equation and Bohr effect | 2 | 3 | 1,2,3 |
| | Myoglobin: Structure, function. | 3 | 3 | 1,2,3 |
| **Unit 4** | **Intrinsically Disordered Regions / Proteins (IDRs / IDPs)** | **9** | | |
| | Sequence and Structural features of IDPs and IDRs | 2 | 4 | 1,2,3 |
| | Molecular interactions and binding with examples (NF*k*B, $N_{TAIL}$) | 3 | 4 | 1,2,3 |
| | Case studies of IDPs as successful drug targets | 4 | 4 | 1,2,3 |
| **Unit 5** | **Structural Resolution Techniques and Biomolecular Interactions** | **9** | | |
| | Circular Dichroism | 2 | 5 | 1,2,3 |
| | X-ray Crystallography | 2 | 5 | 1,2,3 |
| | NMR | 2 | 5 | 1,2,3 |
| | Biomolecular recognition and their complexes: Protein-Protein, Protein-DNA, Protein-RNA and Protein-ligand interactions and their characteristics | 3 | 5 | 1,2,3 |
| **Total Contact Hours** | | **45** | | |

**Recommended Resources**


1. Biophysics: A Physiological Approach" by Patrick F. Dillon. (ISBN:9781107001442, 1107001447)
2. Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience" by Ken Dill and Sarina Bromberg. (ISBN: 9780815344308)
3. Biophysical Techniques" by Iain Campbell and John White. (ISBN:9780199642144)

**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | | | | | End Semester Exam (50%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | | Mid-1 (15%) | | CLA-2 (15%) | | CLA-3 (10%) | | | |
| | | Th | Prac | Th | Prac | Th | Prac | Th | Prac | Th | Prac |
| Level 1 | Remember | 100% | | 80% | | 80% | | 80% | | 70% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | | | 20% | | 20% | | 20% | | 30% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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**Molecular Biology Lab**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 209** | Course Category | **Core Course (CC)** | L-T-P-C | **0** | **0** | **2** | **2** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Acquire hands-on experience with essential molecular biology techniques, including DNA isolation, electrophoresis, melting temperature determination, restriction digestion, ligation, PCR, and transformation of competent cells.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Identify and describe the steps and reagents used in key molecular biology techniques such as agarose gel electrophoresis, DNA isolation, and polymerase chain reaction (PCR). | 2 | 80% | 70% |
| **Outcome 2** | Explain the principles behind methods such as determining the melting temperature of DNA, assessing DNA purity, and preparing competent cells for transformation. | 3 | 80% | 70% |
| **Outcome 3** | Perform molecular biology procedures, including DNA restriction digestion, ligation with T4 DNA ligase, and PCR amplification, to analyze and manipulate DNA samples. | 5 | 80% | 70% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Life long Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 3 | 1 | | 2 | 2 | 3 | 2 |
| Outcome 2 | 3 | 3 | 3 | 3 | 3 | 1 | | 2 | 2 | | | 2 | 2 | 3 | 3 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | 1 | | 1 | 3 | 3 | | 3 | 3 | 3 | 3 |
| **Course Average** | **3** | **3** | **3** | **3** | **3** | **1** | **1** | **1.3** | **2.3** | **2** | | **2.3** | **2.3** | **3** | **2.6** |

**Course Unitization Plan – Lab**

| Exp No. | Experiment Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| 1. | Agarose gel electrophoresis. | 8 | 1 | 1 |
| 2. | Isolation of bacterial genomic DNA | 7 | 1 | 1 |
| 3. | Isolation of Plasmid DNA by Alkali-Lysis method. | 7 | 1 | 1 |
| 4. | Determination of melting temperature (Tm) of DNA. | 5 | 2 | 1 |
| 5. | Determination of purity of DNA. | 5 | 2 | 1 |
| 6. | Restriction digestion of DNA. | 5 | 2 | 1 |
| 7. | Ligation of DNA by T4 DNA ligase. | 8 | 3 | 1 |

| | | | | |
|---|---|---|---|---|
| 8. | Preparation of competent cells by Calcium chloride method and transformation | 10 | 3 | 1 |
| 9. | Polymerase chain reaction. | 5 | 1,3 | 1 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources:**

1. Molecular Cloning: A Laboratory Manual. (2012) Michael Green, Joseph Sambrook. CSHL Press.4th Edition.

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | **End Semester Exam (50%)** |
|---|---|---|---|---|---|
| | | **Experiments (20%)** | **Record / Observation Note (10%)** | **Viva + Model (20%)** | |
| Level 1 | Remember | 50% | | 25% | 25% |
| | Understand | | | | |
| Level 2 | Apply | 50% | 100% | 65% | 60% |
| | Analyse | | | | |
| Level 3 | Evaluate | | | 10% | 15% |
| | Create | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** |

**Course Designers:**

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# SEMESTER 5

**SRM University – AP, Andhra Pradesh**
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Guntur District, Mangalagiri, Andhra Pradesh 522240

## INTRODUCTION TO DEVELOPMENTAL BIOLOGY

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 301** | Course Category | **Core Course (CC)** | L-T-P-C | **3** | **1** | **0** | **4** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

### Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamental aspects of development
2. Understand the general concepts of differential gene expression, cell differentiation, transcription factors and mechanisms of morphogenesis.

### Course Outcomes / Course Learning Outcomes (CLOs)

| | At the end of the course, the learner will be able to | Bloom's Level | Expected Proficiency Percentage | Expected Attainment Percentage |
|---|---|---|---|---|
| **Outcome 1** | Describe the process of fertilization and early embryonic developmental stages | 2 | 70% | 65% |
| **Outcome 2** | Demonstrate the cellular differentiation pathways. | 3 | 70% | 60% |
| **Outcome 3** | Describe the process of invertebrate and vertebrate development. | 2 | 70% | 65% |
| **Outcome 4** | Explain the process of tissue regeneration and aging | 3 | 70% | 60% |

### Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

| | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLOs** | Scientific and Disciplinary K | Analytical Reason | Critical and Reflecti | Scientific Reason | Research Relate | Modern Tools and | Environment and Sustainability | Moral, Multicultural and Ethical | Individual and Team | Communication Skills | Leadership Readines | Self-Directed a | PSO1 | PSO2 | PSO3 |

| | nowledge | ngandProblemSolving | veThinking | ngandDesignThinking | dSkills | ICTUsage | | Awareness | workSkills | | sSkills | ndLifeLongLearning | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 3 | 2 | 2 | 3 | 1 | | | | 1 | | 2 | 3 | 1 | 2 |
| Outcome 2 | 3 | 2 | 2 | 3 | 3 | 1 | | 2 | | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 2 | 2 | 2 | 3 | 1 | | | | | | 2 | 3 | 3 | 3 |
| Outcome 4 | 3 | 2 | 2 | 3 | 2 | 1 | | 2 | | | | 2 | 3 | 3 | 2 |
| **Course Average** | **3** | **2.3** | **2** | **2.5** | **2.8** | **1** | | **2** | | **1** | | **2** | **3** | **2.3** | **2.5** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **INTRODUCTION TO DEVELOPMENTAL BIOLOGY** | **15** | | |
| | Animal development | 4 | 1 | 1, 2 |
| | Fertilization, gastrulation and developmental patterns | 4 | 1 | 1, 2 |
| | Plant development | 4 | 1 | 1, 2 |
| | Fundamental differences between animal and plant development. | 3 | 1 | 1, 2 |
| **Unit 2** | **Molecular Basis of Development** | **15** | | |
| | Concept of differential gene expression | 3 | 2 | 1, 2, 4, 5 |
| | Cell differentiation | 3 | 2 | 1, 2, 4, 5 |
| | Transcription factors | 3 | 2 | 1, 2, 4, 5 |
| | Mechanisms | 3 | 2 | 1, 2, 4, 5 |

| | | | | |
|---|---|---|---|---|
| | of morphogenesis: Morphogen gradients | | | |
| | Major signaling pathways regulating development | 3 | 2 | 1, 2, 4, 5 |
| **Unit 3** | **Invertebrate and Vertebrate Development** | **10** | | |
| | Drosophila development: early development and pattern formation | 3 | 1,2,3 | 2, 3, 4 |
| | Drosophila segmentation, anterior-posterior and dorsal -ventral body plan generation | 3 | 1,2,3 | 2, 3, 4 |
| | Amphibian development: early development and pattern formation | 2 | 1,2,3 | 2, 3, 4 |
| | Amphibian segmentation, anterior-posterior and dorsal -ventral body plan generation | 2 | 1,2,3 | 2, 3, 4 |
| **Unit 4** | **Tissue Regeneration** | **10** | | |
| | Concept of regeneration | 3 | 4 | 1, 4 |
| | Models systems to study regeneration - hydra, planarians, zebrafish | 3 | 4 | 1, 4 |
| | Limb regeneration in axolotls, Regeneration in mammals and Regenerative medicine | 4 | 4 | 1, 4 |
| **Unit 5** | **Aging** | **10** | | |
| | Concept of aging | 2 | 4 | 1, 2, 5 |
| | Hallmarks of aging | 2 | 4 | 1, 2, 5 |
| | Molecular basis of aging: insulin signalling | 2 | 4 | 1, 2, 5 |
| | Dietary restriction, and mitochondrial signalling. | 2 | 4 | 1, 2, 5 |
| **Total contact hours** | | **60** | | |

**Recommended Resources**

1. Developmental Biology (2016). 11th Edition: by Scott F. Gilbert
2. Essential Developmental Biology (2012). 3rd Edition:Jonathan M. W. Slack
3. Principles of Development (2018). 5th Edition: Martinez Arias Wolpert and Tickle
4. Mechanisms in Plant Development (2002). Ottoline Leyser and Stephen Day
5. Cell Signaling (2014). Wendell Lim and Bruce Mayer

**Other Resources**

1. Stem Cells: An Insiders Guide (2013). Paul Knoepfler
2. Molecular Biology of the Cell (2014). 6th Edition. Bruce Alberts

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (50%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | | **Mid-1 (15%)** | | **CLA-2 (10%)** | | **Mid-2 (15%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 80% | | 70% | | 80% | | 80% | | 70% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 20% | | 30% | | 20% | | 20% | | 30% | |
| | Analyse | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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**Genetic Engineering**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 302** | Course Category | **Core Course (CC)** | L-T-P-C | **2** | **1** | **0** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. To understand basic of tools and technique used in genetic engineering
2. To understand concepts and application of rDNA technology in health, agriculture and environment

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the role of genetic engineering in the modern world. | 2 | 80% | 75% |
| **Outcome 2** | Explain tools and methods used for genetic engineering. | 2 | 80% | 75% |
| **Outcome 3** | Explain the role of advanced techniques like sequencing methods and its application in genetic engineering. | 2 | 70% | 65% |
| **Outcome 4** | Describe organismal cloning and ethical debate on organismal cloning. | 3 | 70% | 65% |
| **Outcome 5** | Design molecular techniques to improve and generate genetically modified organisms and its importance. | 3 | 70% | 65% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | | | | 2 | 3 | 1 | 2 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | | 1 | | 2 | 3 | 3 | 3 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | | 1 | | 2 | 3 | 2 | 3 |
| Outcome 5 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | | 3 | 3 | 3 | 2 |
| **Course** | **3** | **2** | **3** | **3** | **2.4** | **1.4** | **2.8** | **3** | **1** | **1.3** | | **2.2** | **3** | **2.2** | **2.6** |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average** | | | | | | | | | | | | | | | |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **Genetic Engineering: Basic Concepts, Bacterial Hosts and Vectors** | **9** | | |
| | Definition of genetic engineering | 2 | 1 | 1,3 |
| | Bacterial strains: Growth and Maintenance, Cloning and colony | 2 | 1 | 1,3 |
| | Plasmids and properties of plasmid cloning vectors | 2 | 1,2 | 1,3 |
| | Prokaryotic and eukaryotic expression plasmid vectors | 2 | 1,2,4 | 1,3 |
| | Transformation and Transfection | 1 | 1 | 1,3 |
| **Unit 2** | **Phage vectors, Libraries and Expression System** | **9** | | |
| | Bacteriophages: Lambda, M13 and Phage vectors | 3 | 2 | 1,2,3 |
| | Cosmids, Yeast artificial chromosomes. | 2 | 2,3 | 1,2,3 |
| | Concepts of Genomic and cDNA libraries | 2 | 2 | 1,2,3 |
| | Inducible vectors | 2 | 2 | 1,2,3 |
| **Unit 3** | **Enzymes and Recombinant DNA Methodologies** | **9** | | |
| | Enzymes used in genetic engineering: Restriction endonucleases, Polymerases, Ligases, Kinases, Endo- and Exonucleases. | 3 | 1,3,5 | 1, 2 |
| | DNA and RNA isolation and their detection, Polymerase chain reaction (qualitative and quantitative) and applications. | 2 | 1,3,5 | 1, 2 |
| | Methods of Genomic and cDNA cloning, Construction of Genomic DNA and cDNA libraries, | 2 | 1,3,5 | 1, 2 |
| | Radioactive and Non-radioactive labelling of nucleic acids and proteins. Methods of screening the libraries . | 2 | 1,3,5 | 1, 2 |
| **Unit 4** | **Protein Expression, Purification and Molecular Interactions** | **9** | | |
| | Recombinant protein expression | 2 | 4 | 1,2,4 |
| | Methods of purification and characterization of tagged and untagged proteins. | 2 | 4 | 1,2,3,4 |
| | Analysis of protein-nucleic acid and protein-protein interactions. | 2 | 4 | 1,2,3,4 |
| | Site-specific and random mutagenesis | 2 | 4 | 1,2,3,4 |
| | DNA and Protein microarrays. | 1 | 4 | 1,2,3,4 |

| | | | | |
|---|---|---|---|---|
| **Unit 5** | **Sequencing Methods and Applications** | **9** | | |
| | Basics of Nucleic acid sequencing methods | 2 | 1,5 | 1,2,3,4 |
| | Antisense and RNA silencing techniques | 2 | 1,5 | 1,2,3,4 |
| | Gene Drives. Methods to generate transgenic bacteria/animals/plants. | 2 | 1,5 | 1,2,3,4 |
| | Genome Editing: Safety and Ethics | 2 | 1,5 | 1,2,3,4 |
| | Genome sequencing and genetic engineering applications in personalized Medicine and Agriculture. | 1 | 1,5 | 1,2,3,4 |
| **Total Contact Hours** | | **45** | | |

**Recommended Resources**

1. J. Sambrook and D. W. Russell, Molecular Cloning: A Laboratory Manual, 3rd Edn: Vol. I, II, & III, Cold Spring Harbor Laboratory Press
2. S. B. Primrose and R. M. Twyman. Principles of Gene Manipulation and Genomics, 7th Ed., Blackwell Publishing
3. Fred Ausubel and Others. Current Protocols in Molecular Biology. Wiley.
4. Gurbachan S. Miglani, Genome Editing: A Comprehensive Treatise. Alpha Science International Ltd.

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (50%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | | **Mid-1 (15%)** | | **CLA-2 (10%)** | | **Mid-2 (15%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 40% | | 60% | | 40% | | 60% | | 30% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 60% | | 40% | | 60% | | 40% | | 70% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

*a. Dr. Sutharsan Govindarajan. Assistant Professor, Dept. Of Biological Sciences. SRM University – AP*

*b. Prof. Jayaseelan Murugaiyan. Professor & Head. Dept. Of Biological Sciences. SRM University – AP*

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Neerukonda, Mangalagiri Mandal
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# Immunobiology

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 303** | Course Category | **Core Course (CC)** | L-T-P-C | **2** | **1** | **0** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

1. The students will be able to identify the cellular and molecular basis of immune responsiveness.
2. The students will be able to understand the roles of the immune system in both maintaining health and contributing to disease.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the cell types and organs present in the innate and adaptive immunity. | 2 | 80% | 75% |
| **Outcome 2** | Summarize effector molecules and responses in immune activation. | 2 | 70% | 65% |
| **Outcome 3** | Apply the techniques of antigen-antibody interactions to demonstrate immunoassay principles. | 3 | 70% | 65% |
| **Outcome 4** | Illustrate the stages of transplantation immunology based on immune tolerance mechanisms. | 2 | 70% | 65% |
| **Outcome 5** | Describe the reasons for immunization and vaccination. | 2 | 80% | 75% |

## Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

| | **Program Learning Outcomes (PLO)** |
|---|---|

| **CLOs** | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Life Long Learning | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | 1 | | | | | | 2 | 3 | 1 | 2 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | 1 | | | | | | 2 | 3 | 2 | 2 |
| Outcome 3 | 3 | 2 | 3 | 3 | 3 | 1 | | | | | | 2 | 3 | 2 | 3 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 1 | | 2 | | 2 | | 2 | 3 | 3 | 3 |
| Outcome 5 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | | 2 | | 3 | 3 | 3 | 3 |
| **Course Average** | **3** | **2** | **3** | **3** | **2.4** | **1.4** | **1** | **1.5** | | **2** | | **2.2** | **3** | **2.2** | **2.6** |

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **INTRODUCTION TO IMMUNOLOGY** | **9** | | |
| | Overview of defense mechanisms in animals | 3 | 1 | 1, 2 |
| | Hematopoiesis | 2 | 1 | 1, 2 |
| | Cells of the immune system | 2 | 1 | 1, 2 |
| | Primary and secondary lymphoid organs and tissues | 2 | 1 | 1, 2 |
| **Unit 2** | **INNATE IMMUNITY** | **9** | | |
| | Anatomical barriers and cell types of innate immunity | 2 | 1, 2 | 1, 2 |
| | Soluble molecules and membrane associated receptors (PRR) | 1 | 1, 2 | 1, 2 |
| | Connections between innate and adaptive immunity | 1 | 1,2 | 1, 2 |
| | Cell adhesion molecules and chemokines | 1 | 2 | 1, 2 |
| | Leukocyte extravasation,localized and systemic response | 1 | 2 | 1, 2 |
| | Complement activation by classical, alternate and MBL pathway | 1 | 2 | 1, 2 |
| | Biological consequences of complement activation | 1 | 2 | 1, 2 |
| | Regulation and complement deficiencies | 1 | 2,4 | 1, 2 |
| **Unit 3** | **ADAPTIVE IMMUNITY** | **9** | | |
| | Antigens and haptens<br>Factors that dictate immunogenicity<br>B and T cell epitopes | 1 | 1,3,4 | 1, 2 |
| | Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody | 1 | 1,3,4 | 1, 2 |
| | Antigenic determinants on Ig and Ig super family<br>Generation of antibody Diversity | 1 | 1,3,4 | 1, 2 |
| | Monoclonal antibodies | 1 | 1,3,4 | 1, 2 |
| | Immunological methods- Antigen-antibody interactions | 1 | 3 | 1, 2 |
| | Histocompatibility antigens - HLA and Disease | 1 | 3 | 1, 2 |
| | T cell differentiation – Positive and Negative selection<br>Antigen Presentation | 1 | 3 | 1, 2 |
| | Activation of T and B cells | 1 | 3, 4, 5 | 1, 2 |
| | Cytokines and Chemokines | 1 | 2, 3, 4, 5 | 1, 2 |
| **Unit 4** | **IMMUNE DYSFUNCTION AND DISEASE** | **9** | | |
| | Immunological tolerance | 2 | 4 | 1, 2 |

| | | | | |
|---|---|---|---|---|
| | Immunological disorders – Hypersensitivity and Autoimmune diseases | 1.5 | 4 | 1, 2 |
| | Immunodeficiencies | 1.5 | 4 | 1, 2 |
| | Transplantation Immunology | 1.5 | 4 | 1, 2 |
| | Immune response against major classes of pathogens | 2.5 | 4 | 1, 2 |
| **Unit 5** | **Vaccines** | **9** | | |
| | Introduction to vaccines and History of the development of vaccines | 2 | 1,5 | 1, 2 |
| | Types of vaccines | 2 | 1,5 | 1, 2 |
| | Adjuvants | 2 | 1,5 | 1, 2 |
| | Immunization –routes and responses | 2 | 1,5 | 1, 2 |
| | Future of vaccine biology | 1 | 1,5 | 1, 2 |
| **Total Contact Hours** | | **45** | | |

**Recommended Resources**

1. Kuby Immunology (2018), 8th edition.Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen
2. William Paul, Fundamental Immunology, 7th edition. 2013

**Other Resources**

1. BiteSized Immunology (https://www.immunology.org/public-information/bitesized-immunology)

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (50%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | | **Mid-1 (15%)** | | **CLA-2 (10%)** | | **Mid-2 (15%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 40% | | 60% | | 40% | | 40% | | 30% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 60% | | 40% | | 60% | | 60% | | 70% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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**Genetic Engineering Lab**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 304** | Course Category | **Core Course (CC)** | L-T-P-C | **0** | **0** | **2** | **2** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

**Objective 1:** To develop proficiency in essential molecular biology techniques, including site-directed mutagenesis, plasmid preparation, and transformation of competent E. coli, for manipulating and analyzing genetic material.
**Objective 2:** To gain expertise in protein analysis methods such as cell harvesting, protein extraction, SDS-PAGE, and Western blotting, complemented by bioinformatics tools for sequence analysis and comparison.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Perform site-directed mutagenesis, plasmid preparation, and E. coli transformation. | 4 | 80% | 70% |
| **Outcome 2** | Conduct cell harvesting, protein extraction, and SDS-PAGE analysis. | 3 | 80% | 70% |
| **Outcome 3** | Execute Western blotting for His-tagged proteins and interpret results. | 4 | 80% | 70% |
| **Outcome 4** | Use bioinformatics tools for sequence analysis and comparison. | 4 | 75% | 65% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 3 | 3 | 3 | 3 | | | 2 | 3 | 1 | | 3 | 2 | 3 | 3 |
| Outcome 2 | 3 | 3 | 3 | 3 | 3 | | | | 2 | 1 | | 3 | 2 | 3 | 3 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | | | | 3 | 2 | | 3 | 3 | 3 | 3 |
| Outcome 4 | 3 | 3 | 3 | 3 | 3 | 2 | | | 3 | 3 | | 3 | 2 | 3 | 3 |
| **Course Average** | **3** | **3** | **3** | **3** | **3** | **2** | | **2** | **2.7** | **1.7** | | **3** | **2.2** | **3** | **3** |

**Course Unitization Plan – Lab**

| Exp No. | Experiment Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| 1. 1. | Site directed mutagenesis, | 10 | 1 | 1 |
| 2. 2 | Transformation of competent E. coli | 5 | 1 | 1 |
| 3. 3 | Plasmid preparation | 5 | 1 | 1 |
| 4. 4. | Sequence analysis and comparison using bioinformatics tools. | 10 | 4 | 1 |
| 5. 5. | Cell harvesting and protein extraction | 5 | 2 | 1 |
| 6. 6. | Protein expression analysis via SDS-PAGE | 15 | 2 | 1 |
| 7. 7. | Western blotting (His-Tag protein) | 10 | 3 | 1 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources:**

1. Molecular Cloning: A Laboratory Manual, 4th edition. Michael R. Green,. Joseph Sambrook. CSHL Press.

**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | End Semester Exam (50%) |
|---|---|---|---|---|---|
| | | Experiments (20%) | Record / Observation Note (10%) | Viva + Model (20%) | |
| Level 1 | Remember | 50% | | 35% | 20% |
| | Understand | | | | |
| Level 2 | Apply | 50% | 100% | 65% | 80% |
| | Analyse | | | | |
| Level 3 | Evaluate | | | | |
| | Create | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** |

**Course Designers:**

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**Plant and Animal Physiology**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 305** | Course Category | **Core Course (CC)** | L-T-P-C | **3** | **1** | **0** | **4** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. To gain knowledge about plants stress response and adaptation mechanisms and their relevance to crop productivity.
2. Understand the physiology across levels, from molecular to organismal, and understand interactions between different physiological systems of animals.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the role of plants and photosynthesis in sustaining life on earth. | 2 | 80% | 75% |
| **Outcome 2** | Discuss photosynthesis and role of photoreceptors, phytohormones, nutrients in plant development. | 2 | 70% | 65% |
| **Outcome 3** | Analyse the type of stress in plants and mitigation strategies. | 4 | 70% | 65% |
| **Outcome 4** | Illustrate the functional organization of an animal and the mechanisms of maintaining homeostasis | 2 | 70% | 65% |
| **Outcome 5** | Describe the structure, organization and function of different organ systems of the human body | 2 | 70% | 65% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 1 | 2 | 2 | 1 | | 3 | | | | | 2 | 3 | 1 | 2 |
| Outcome 2 | 3 | 2 | 2 | 3 | 2 | 1 | 2 | | | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 2 | 1 | 2 | 1 | | 2 | | | | | 2 | 3 | 3 | 2 |
| Outcome 4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | | | | 2 | 3 | 3 | 3 |
| Outcome 5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | | 2 | | | 3 | 3 | 3 | 3 |
| **Course Average** | **3** | **2.2** | **2.2** | **2.6** | **2.5** | **2** | **2.3** | | **2** | | | **2.2** | **3** | **2.4** | **2.6** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **Basic Plant Physiology** | **12** | | |
| | Transport system | 2 | 1 | 1 |
| | Micro and macro nutrients | 2 | 1 | 1, 2 |
| | Nitrogen metabolism | 2 | 1 | 1, 2 |
| | Photosynthesis, respiration and photorespiration | 2 | 1 | 1 |
| | Transpiration | 2 | 1,3 | 1 |
| | Photomorphogenesis: response to light | 2 | 1, 3 | 1 |
| **Unit 2** | **Plant growth regulators** | **12** | | |
| | Plant growth regulators | 1 | 1,3 | 1, 2 |
| | Auxins and their physiological roles | 2 | 1,3 | 1, 2 |
| | Gibberellins and their physiological roles | 2 | 1,3 | 1, 2 |
| | Cytokinins and their physiological roles | 2 | 1,3 | 1, 2 |
| | Abscissic acid and their physiological roles | 2 | 1,3 | 1, 2 |
| | Ethylene and their physiological role | 1 | 1,3 | 1, 2 |
| | Practical application of plant growth regulators in crop productivity | 2 | 1,3 | 1, 2 |
| **Unit 3** | **Plant stress response** | **12** | | |
| | Overview of biotic and abiotic stresses | 2 | 3 | 1 |
| | Salinity stress - physiological changes | 2 | 3 | 1 |
| | Adaptation to drought and amelioration | 3 | 3 | 1 |
| | Plant-pathogen interactions | 3 | 3 | 1 |
| | Programmed cell death, aging and senescence | 2 | 3 | 1 |
| **Unit 4** | **Introduction to Physiology** | **12** | | |
| | Organization of human body | 3 | 4,5 | 3 |
| | Extracellular fluid and the internal environment | 3 | 4 | 3 |
| | Concept of Homeostasis | 2 | 4 | 3 |
| | Thermoregulation | 2 | 4,5 | 3 |
| | Osmoregulation | 2 | 4 | 3 |
| **Unit 5** | **Physiology of Organ Systems** | **12** | | |
| | Skeletal and muscular systems | 2 | 5 | 3 |
| | Integumentary and nervous systems | 2 | 5 | 3 |
| | Respiratory and digestive systems | 2 | 5 | 3 |
| | Excretory and cardio-vascular systems | 2 | 5 | 3 |
| | Endocrine and lymphatic (immune) systems | 2 | 5 | 3 |
| | Reproductive systems | 2 | 5 | 3 |

| Total Contact Hours | **60** |
|---|---|

**Recommended Resources**

1. Taiz and Zeiger, Plant Physiology
2. Buchnan, B. B., Gruissem, W. and Jones, R. L., Biochemistry and molecular biology of plants
3. Barret et al. Ganong's Review of Medical Physiology. 26th edition, McGraw Hill Education.

**Other Resources**

1. Teaching tools in plant biology (https://academic.oup.com/plcell/pages/teaching-tools-plant-biology)

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (50%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | | **Mid-1 (15%)** | | **CLA-2 (10%)** | | **Mid-2 (15%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 80% | | 80% | | 80% | | 70% | | 70% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 20% | | 20% | | 20% | | 30% | | 30% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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## Course Name: Career Skills for Lifesciences-I

| Course Code | | Course Category | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | |
| Course Offering Department | | Professional / Licensing Standards | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

- Help students identify career paths, aligning personal strengths with industry opportunities.
- Equip students with skills in resume writing, cover letters, and interview techniques.
- Enhance students' scientific communication, ethical understanding, and professionalism in life sciences.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | At the end of the course the learner will be able to | Bloom's Level | Expected Proficiency Percentage | Expected Attainment Percentage |
|---|---|---|---|---|
| **Outcome 1** | Students will be able to identify various career paths in life sciences and map potential trajectories that align with their skills and interests. | **2** | **85%** | **755** |
| **Outcome 2** | Create tailored resumes and persuasive cover letters for life sciences roles. | **4** | **80%** | **70%** |
| **Outcome 3** | Apply effective interview and networking strategies for career advancement. | **3** | **75%** | **70%** |
| **Outcome 4** | Demonstrate ethical standards and professionalism in scientific settings. | **3** | **75%** | **70%** |
| **Outcome 5** | Communicate scientific ideas effectively using presentation skills and visual aid**s.** | **3** | **75%** | **70%** |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO 1 | PSO 2 | PSO 3 |
| **Outcome 1** | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 3 | **1** | **1** | **3** |
| **Outcome 2** | 3 | 1 | 2 | 1 | 1 | 3 | | 1 | 2 | 3 | 2 | 2 | **1** | **1** | **3** |
| **Outcome 3** | 1 | 1 | 2 | 1 | 1 | 2 | | 2 | 3 | 3 | 2 | 2 | **1** | **1** | **3** |
| **Outcome 4** | 1 | 1 | 2 | 1 | 1 | 1 | | 3 | 2 | 2 | 2 | 2 | **2** | **1** | **3** |
| **Outcome 5** | 1 | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | 3 | 1 | 2 | **2** | **1** | **3** |
| **Average** | **2** | **1** | **2** | **1** | **1** | **2** | **1** | **2** | **2** | **3** | **2** | **2** | **1** | **1** | **3** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| Unit 1 | **Overview of Life Sciences Careers** | **1** | 1 | 2 |
| | Job roles and industries | 2 | 1 | 2 |
| | Emerging trends and opportunities | 2 | 1 | 2 |
| | **Career Path Mapping** | 1 | 1 | 2 |
| | Identifying personal interests and strengths | 1 | 1 | 2 |
| | Researching potential career trajectories | 2 | 1 | 2 |
| Unit 2 | **Resume Writing Workshop** | **2** | 2 | 2,3 |
| | Key elements of an effective resume tailored to life sciences | 2 | 2 | 2,3 |
| | Customizing resumes for specific roles | 1 | 2 | 2,3 |
| | **Cover Letter Crafting** | 2 | 2 | 2,3 |
| | Writing persuasive cover letters | 1 | 2 | 2,3 |
| | Techniques for showcasing relevant experience | 1 | 2 | 2,3 |
| Unit 3 | **Interview Techniques** | **1** | 3 | 4 |
| | Common interview questions in life sciences | 2 | 3 | 4 |
| | Behavioral and situational interview strategies | 2 | 3 | 4 |
| | **Networking Essentials** | 1 | 3 | 4 |
| | Importance of networking in life sciences | **1** | 3 | 4 |
| | Building professional relationships and using platforms like LinkedIn | **2** | 3 | 4 |
| Unit 4 | **Understanding Ethical Issues in Life Sciences** | **2** | 4 | 1 |
| | Overview of ethical guidelines and standards | 2 | 4 | 1 |
| | Case studies on ethics in research and professional practice | 1 | 4 | 1 |
| | **Professional Etiquette** | 1 | 4 | 1 |
| | Workplace behavior and communication | 2 | 4 | 1 |
| | Managing conflicts and professionalism in scientific interactions | 1 | 4 | 1 |

| | | | | |
|---|---|---|---|---|
| **Unit 5** | **Effective Science Communication** | **1** | 5 | 1 |
| | Tailoring messages for different audiences (public, peers, stakeholders) | 2 | 5 | 1 |
| | Utilizing visual aids and data presentation techniques | 2 | 5 | 1 |
| | **Public Speaking and Presentation Skills** | 1 | 5 | 1 |
| | Structuring scientific presentations | 1 | 5 | 1 |
| | Tips for engaging an audience and handling Q&A sessions | 2 | 5 | 1 |

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (100%)** | | | |
|---|---|---|---|---|---|
| | | **CLA-1 25%** | **Mid-1 25%** | **CLA-2 25%** | **CLA-3 25%** |
| **Level 1** | Remember | 20 | 30 | 20 | 20 |
| | Understand | | | | |
| **Level 2** | Apply | 80 | 70 | 80 | 80 |
| | Analyse | | | | |
| **Level 3** | Evaluate | | | | |
| | Create | | | | |
| **Total** | | | | | |

**Recommended Resources**

1. *"Scientific Writing and Communication: Papers, Proposals, and Presentations"* by Angelika H. Hofmann, Oxford University Press, 2010, ISBN · 9780197613795
2. Freedman, T., 2008. Career opportunities in biotechnology and drug development. CSHL Press, 2008 ; ISBN, 0879697253
3. *Indeed Career Advice* (www.indeed.com/career-advice)
4. *"The New Rules of Work"* by Alexandra Cavoulacos and Kathryn Minshew, 2017. **ISBN** 9781984823168

**Course Designers**

**1.** Dr. Writoban Basu Ball, Assistant Professor, Dept. of Biological Sciences, SRM University-AP.

# SEMESTER 6

**SRM University – AP, Andhra Pradesh**

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Guntur District, Mangalagiri, Andhra Pradesh 522240

**Introduction to Biotechnology**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BI0 306** | Course Category | **Core Course (CC)** | L-T-P-C | **2** | **1** | **0** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Understand the history, significance, and commonly utilized materials, such as plasmids and vectors, in the field of biotechnology.
2. Learn the principles and techniques of gene and genome editing, including CRISPR-Cas9 and other emerging technologies**.**

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the importance and basics of biotechnology and historical breakthrough in the field. | 1 | 70% | 65% |
| **Outcome 2** | Expalin the principles of gene and genome editing. | 2 | 70% | 65% |
| **Outcome 3** | Describe the importance of microorganisms, plants, and animal systems in various industrial processes, involving genetic engineering strategies. | 2 | 70% | 65% |
| **Outcome 4** | Explain the regulatory aspects and ethical considerations in animal and medical biotechnology. | 2 | 70% | 65% |

**Course Articulation Matrix (CLO) to (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | **3** | **1** | **1** | **1** | **1** | **1** | **1** | | **2** | | | **1** | **3** | **3** | **2** |
| Outcome 2 | **3** | **2** | **2** | **2** | **1** | **1** | **1** | | **1** | | | **1** | **3** | **3** | **3** |
| Outcome 3 | **3** | **2** | **1** | **2** | **1** | **1** | **2** | | **1** | | | **1** | **3** | **3** | **3** |
| Outcome 4 | **3** | **1** | **2** | **1** | **1** | **1** | **2** | **3** | **1** | **1** | | **1** | **3** | **2** | **3** |
| **Course Average** | **3** | **1.5** | **1.5** | **1.5** | **1** | **1** | **1.5** | **3** | **1.3** | **1** | | **1** | **3** | **2.8** | **2.8** |

**Course Unitization Plan - Theory**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Unit 1** | **Introduction to Biotechnology** | **7** | | |
| | Biotechnology: Scope and Importance; History of biotechnology | 2 | 1 | 4 |
| | Types of vectors: Plasmid vectors, Bacteriophage lambda and M13 based vectors | 2 | 1 | 1,2 |
| | Cosmids, Shuttle vectors, Expression vectors, Baculovirus-based vectors, Ti based vectors (Binary and Cointegrated vectors). | 3 | 1 | |
| **Unit 2** | **Genome Editing and Gene Delivery Methods** | **14** | | |
| | The process of Genetic Engineering; Protoplast and cell fusion technologies; | 2 | 2 | 1,2 |
| | Genome engineering tools – Conventional methods (Mutagenesis, Knock-in, Knock-out, conditional knock-outs), | 4 | 2 | 1,2 |
| | Modern methods using engineered Nucleases (Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALENs), Clustered regularly interspaced short palindromic repeats (CRISPR)) | 5 | 2 | 1,2 |
| | Gene delivery techniques: Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium-mediated delivery. | 3 | 2 | 1,2 |
| **Unit 3** | **Microbial Biotechnology** | **9** | | |
| | Methods of fermentation; Industrial Bioprocesses: Ethanol, Lactic acid production – Citric acid, acetic acid, | 4 | 3 | 4 |
| | Streptomycin, beer, Amylase and protease, vitamin B12, PHA, biofertilizers, vermicompost, biopesticides; Bacillus thuringiensis, recombinant insulin and hepatitis B; | 4 | 3 | 4 |
| | Waste water management by microbes | 1 | 3 | 4 |
| **Unit 4** | **Plant and Algal Biotechnology** | **10** | | |
| | Engineering of insect resistant plants and disease resistant crops. Genetically modified food products; BT crops: Transgenics rice, Cotton, Brinjal; | 4 | 3 | 3 |
| | Biofuels from algae: Biodiesel, biohydrogen, methanol and electricity generation. | 3 | 3 | 3 |
| | Nanoscience and technology for the production of bioproducts from algae. Bioremediation and Phycoremediation. | 3 | 3 | 3 |
| **Unit 5** | **Animal and Medical Biotechnology** | **5** | | |

| | | | | |
|---|---|---|---|---|
| | Basic principles of organismal cloning and challenges. Cloned animals: Carp the fish, Dolly the sheep. Dehorning of calves. | 3 | 4 | 5 |
| | Sickle cell therapy, CRISPR babies, Ethical debate on organismal cloning. | 2 | 4 | 5 |
| **Total Contact Hours** | | **45** | | |

**Recommended Resources**


1. Gene Cloning and DNA Analysis: An Introduction. 8th edition (2020). T. A. Brown. WileyBlackwell.
2. Principles Of Gene Manipulation And Genomics, 7th edition (2014). Primrose S.B. WileyBlackwell.
3. Introduction to Biotechnology: International Edition, 2nd edition (2008). William J. Thieman, Michael A. Palladino. Pearson International.
4. Textbook of Biotechnology, 5th edition (2017). H.K. Das. Wiley.
5. Textbook of Animal Biotechnology, (2016). Carlos Wyatt. Syrawood Publishing house.


**Learning Assessment (Theory)**

| **Question Difficulty** | **Bloom's Level of Cognitive Task** | **Continuous Learning Assessments (50%)** | | | | **End Semester Exam (50%)** |
|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | **Mid-1 (15%)** | **CLA-2 (10%)** | **CLA-3 (15%)** | |
| Level 1 | Remember | 100% | 100% | 100% | 100% | 100% |
| | Understand | | | | | |
| Level 2 | Apply | | | | | |
| | Analyse | | | | | |
| Level 3 | Evaluate | | | | | |
| | Create | | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** | **100%** |

**Course Designers**


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**Fundamentals of Bioinformatics**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 307** | Course Category | **Core Elective Course (CE)** | L-T-P-C | **2** | **1** | **0** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

1. To explain the bioinformatics data analysis and available databases and their objectives and applications.
2. To explore the bioinformatics methods available for sequence and structural analysis of genes, genomes and proteins using databases and softwares.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the fundamentals of bioinformatics | 1 | 80% | 75% |
| **Outcome 2** | Demonstrate usage of available databases and interpret results | 2 | 85% | 80% |
| **Outcome 3** | Explain bioinformatics algorithms, methods and softwares. | 3 | 70% | 60% |
| **Outcome 4** | Describe and adapt the bioinformatics tools to perform phylogenetic and evolutionary analysis. | 3 | 70% | 65% |

## Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowl | Analytical Reasoning a | Critical and Reflective T | Scientific Reasoning a | Research Related Sk | Modern Tools and ICT | Environment and Sustainability | Moral, Multicultural and Ethical Aware | Individual and Team wor | Communication Skills | Leadership Reading ess Ski | Self-Directed and L | PSO1 | PSO2 | PSO3 |

| | edge | ndProblemSolving | hinking | ndDesignThinking | ills | Usage | | ness | kSkills | | lls | ifeLongLearning | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 3 | 3 | 2 | 3 | 1 | | 3 | 2 | 3 | | 3 | 2 | 1 | 3 |
| Outcome 2 | 3 | 2 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | | | 3 | 3 | 2 | 3 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 2 | 2 | | | 3 | 3 | 3 | 2 |
| Outcome 4 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | | | 3 | 2 | 3 | 2 |
| **Course Average** | **3** | **2.8** | **3** | **2.8** | **3** | **2** | **1** | **2.3** | **2.3** | **3** | | **3** | **2.5** | **2.3** | **2.5** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **Introduction to Bioinformatics** | **10** | | |
| | Concept of omics | 2 | 1 | 1, 2 |
| | Genomics, transcriptomics, proteomic and metabolomics | 3 | 1 | 1, 2 |
| | Instrumental methods of biological sequence analysis and large scale metabolite analysis | 3 | 1 | 1, 2 |
| | DNA, RNA and Protein sequences, Ontology | 2 | 1 | 1, 2 |
| **Unit 2** | **Nucleic Acids** | **10** | | |
| | Primary and Secondary databases. Database formats and file formats. FASTA format. | 2 | 1, 2 | 2, 3 |

| | | | | |
|---|---|---|---|---|
| | Public databases and repositories: NCBI, EBI, GenBank, DDBJ, EMBL, PIR and Uniprot. | 3 | 1, 2 | 2, 3 |
| | Specialized databases: NCBI, Pubmed, OMIM, Medical databases, KEGG and EST databases. | 3 | 1, 2 | 2, 3 |
| | Gene Ontology (GO), Gene Ontology Annotation (GOA) databases. | 2 | 1, 2, 3 | 2, 3, 5 |
| **Unit 3** | **Proteins** | **10** | | |
| | Databases: SwissProt, PRF, Protein Data Bank, DisProt, SCOP, CATH | 3 | 1, 2 | 3 |
| | File formats: .pdb, .mmcf, .cif; Protein Ontology (PRO) | 2 | 1, 3 | 2, 3 |
| | Structure prediction, Homology modelling. | 3 | 1, 2, 3 | 2, 3, 4 |
| | Docking, Fundamentals of Biomolecular simulations | 2 | 1, 2 | 1, 2 |
| **Unit 4** | **Database Searches and Sequence Alignment** | **8** | | |
| | Introduction, Evolutionary basis of sequence alignment, Modular nature of proteins | 2 | 1, 3, 4 | 2, 3 |
| | Substitution scores, Substitution matrices, Gap penalties, Statistical significance of Alignments | 3 | 1, 3, 4 | 2, 4 |
| | Database similarity searching, FASTA, BLAST. Pairwise and Multiple Sequence Alignment, Motifs and Patterns. | 3 | 1, 3, 4 | 3, 4 |
| **Unit 5** | **Phylogenetic Analysis** | **7** | | |
| | Introduction to Phylogenetic analysis, rooted and unrooted trees, Elements of phylogenetic Models | 2 | 1, 3 | 5, 6 |
| | Phylogenetic Data Analysis: Alignment, Substitution Model Building, Tree Building, and Tree Evaluation, | 2 | 1, 3, 4 | 5, 6 |
| | Tree: Building Methods, Distance based and character-based methods, Evaluating Trees and Data- Bootstrapping (parametric and non-parametric), Phylogenetic software | 3 | 1, 3, 4 | 5, 6 |
| **Total Contact hours** | | **45 hours** | | |

**Recommended Resources**


1. Bioinformatics: Methods and Applications by Singh and Pathak (2021), Academic Press.
2. Applied bioinformatics by Selzer, Marhofer, Koch, 2nd edition (2018), Springer.
3. Bioinformatics Database Systems by Byron, Herbert and Wang (2016), CRC Press.
4. Biomolecular simulations in structure based drug discovery by Gervasio and Spiwok (2019), Wiley.
5. Evolutionary Bioinformatics by Forsdyke, 3rd edition (2016), Springer.
6. Bioinformatics for Evolutionary Biologists: A problems approach by Haubold and Haubold (2018), Springer.

**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | | | | | End Semester Exam (50%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | | Mid-1 (15%) | | CLA-2 (10%) | | Mid-2 (15%) | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 60% | | 60% | | 50% | | 30% | | 20% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 40% | | 40% | | 50% | | 70% | | 80% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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# NEUROBIOLOGY

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 308** | Course Category | **Core Course (CC)** | L-T-P-C | **3** | **1** | **0** | **4** |
| Pre-Requisite Course(s) | **BIO 202; BIO 205; BIO 301** | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

1. To comprehend the cell types, anatomy, and organization of the nervous system, including the gross anatomy of the brain, CNS, and PNS
2. Gain understanding of neuropathology, including diseases associated with neuronal dysfunction, and degeneration – Amyotrophic Lateral Sclerosis (ALS), Alzheimer's disease, and Parkinsons disease.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the cell types, anatomy, and organization of the nervous system, distinguishing between the structures of the brain, CNS, and PNS | 2 | 80% | 75% |
| **Outcome 2** | Describe the molecular aspects of neural development, showcasing an ability to explain neural induction, neurogenesis, neuronal specification, and axon guidance | 2 | 75% | 70% |
| **Outcome 3** | Describe neurophysiology and synaptic transmission, display an ability to explain principles of membrane excitability, resting membrane potential, action potential and apply these concepts predict ion flow across the neuronal membrane; explain the components of the pre and post synapse and principles underlying neurotransmission | 3 | 70% | 65% |
| **Outcome 4** | Describe and explain sensory (gustation, olfaction, vision, auditory, somatosensory -sensory transduction, pathway from sense organs to the brain) and motor systems (upper and lower motor neurons, neuromuscular junction, and muscle contraction) | 2 | 75% | 65% |
| **Outcome 5** | Explain the concept of neurodegenerative disorders, and describe Alzheimer's disease, | 2 | 75% | 65% |

| | | | | |
|---|---|---|---|---|
| | Parkinsons disease and Amyotrophic lateral sclerosis (gene mutations and hypothesis leading to neuronal death) | | | |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Life Long Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | 1 | | | | 3 | | 2 | 3 | 1 | 2 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | 1 | | | | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | 1 | | | 1 | 3 | | 2 | 3 | 3 | 2 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 1 | | | 1 | 3 | | 3 | 3 | 3 | 3 |
| Outcome 5 | 3 | 2 | 3 | 3 | 2 | 1 | | 2 | 1 | | | 2 | 3 | 2 | 3 |
| **Course Aver** | **3** | **2.2** | **3** | **3** | **2.2** | **1** | | **2** | **1** | **3** | | **2.2** | **3** | **2.2** | **2.6** |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **age** | | | | | | | | | | | | | | |

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **INTRODUCTION TO NERVOUS SYSTEM** | **12** | | |
| | Introduction to the nervous system, concept of CNS and PNS | 2.5 | 1 | 1, 2, 4, 5 |
| | Neurons and glia | 3 | 1 | 1, 2, 4, 5 |
| | Neuroanatomy (gross structure of human brain, dorsal and ventral view, lobes of the brain, sagittal and coronal view) | 3.5 | 1 | 1, 2, 4, 5 |
| | Skull, meninges, ventricles and cerebrospinal fluid, spinal cord, cranial and spinal nerves | 3 | 1 | 1, 2, 4, 5 |
| **Unit 2** | **NEURAL DEVELOPMENT** | **12** | | |
| | Introduction to the development of the nervous system – fertilization & gastrulation | 2 | 2 | 1,3,4 |
| | Neurulation, formation of brain vesicles | 2 | 2 | 1,3,4 |
| | Neural tube patterning – anteroposterior axis & dorsoventral axis, neurogenesis | 2 | 2 | 1,3,4 |
| | Neuronal migration, Dendritogenesis, axon guidance, | 3 | 2 | 1,3,4 |
| | Synapse formation, cortical histogenesis | 3 | 2 | 1,3,4 |
| **Unit 3** | **NEUROPHYSIOLOGY AND NEUROTRANSMISSION** | **16** | | |
| | Introduction ton neurophysiology and neurotransmission, Membrane transport & excitability | 3 | 3 | 2,5 |
| | Resting membrane potential & action potential | 3 | 3 | 2,5 |
| | Tools to study electrical properties of neurons | 2 | 3 | 2,5 |
| | Synapses: types, pre and post-synapse: Structure and composition | 3 | 3 | 2,5 |
| | Neurotransmitter systems and principles of neurotransmission, neural code | 5 | 3 | 2,5 |
| **Unit 4** | **SENSORY AND MOTOR SYSTEMS** | **12** | | |
| | Introduction to sensory and moto systems, chemical senses-gustation and olfaction | 3 | 4 | 1,5 |
| | Eye and the visual system – retinal, sensory transduction, pathway followed from eye to brain | 2 | 4 | 1,5 |
| | Auditory system – sensory transduction and path from inner ear to the brain | 2 | 4 | 1,5 |
| | Somatosensory system – sensory transduction and pathway to the brain | 2 | 4 | 1,5 |

| | | | | |
|---|---|---|---|---|
| | Motor system – spinal motor system, neuromuscular junction, muscle contraction | 3 | 4 | 1,5 |
| **Unit 5** | **NEUROPATHOLOGY** | **08** | | |
| | Diseases associated with neuronal dysfunction and degeneration | 2 | 5 | 4,5,6 |
| | Alzheimer's Disease | 2 | 5 | 4,5,6 |
| | Parkinsons Disease | 2 | 5 | 4,5,6 |
| | Amyotrophic Lateral Sclerosis | 2 | 5 | 4,5,6 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources**

1. Neuroscience- Exploring the Brain. Mark F Bears. 2016. 4th international edition. Lww
2. Neuroscience. 2018. Dale Purves. 2018. 6th edition. OUP USA
3. Development of the Nervous system. Dan H Sanes. 2019. 4th edition. Academic Press Inc.
4. Principles of Neurobiology. Liqun Luo. 2015. Ist edition. Garland Science
5. Principles of Neural Science. Eric R. Kandel. 2012. 5th edition. McGraw Hill Education
6. Neurodegeneration, Anthony Schapira. 2017, Ist edition, Wiley

**Other Resources**

1. BrainFacts.org

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | **End Semester Exam (50%)** |
|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | **Mid-1 (15%)** | **CLA-2 (10%)** | **CLA-3 (15%)** | |
| | | **Th** | **Th** | **Th** | **Th** | **Th** |
| Level 1 | Remember | 100% | 100% | 80% | 100% | 80% |
| | Understand | | | | | |
| Level 2 | Apply | | | 20% | | 20% |
| | Analyse | | | | | |
| Level 3 | Evaluate | | | | | |
| | Create | | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** | **100%** |

**Course Designers**

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**Introduction To Disease Biology**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 309** | Course Category | **DC** | L-T-P-C | **3** | **1** | **0** | **4** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

1. Understand the molecular bases of pathological, pathophysiological and genetic disorders.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the cellular and biochemical classifications of pathogens | 2 | 80% | 75% |
| **Outcome 2** | Describe the molecular aspects of viral pathogenesis | 2 | 75% | 70% |
| **Outcome 3** | Describe neurophysiology and synaptic transmission discrepancies in neurological disorders | 2 | 70% | 65% |
| **Outcome 4** | Describe and explain the cause and prognosis of genetic disorders | 2 | 75% | 65% |
| **Outcome 5** | Explain the underlying pathogenesis of age-related diseases. | 2 | 75% | 65% |

| **Unit No.** | **Unit Name** | **Required Contact Hours** | **CLOs Addressed** | **References** |
|---|---|---|---|---|
| **UNIT I** | **INTRODUCTION TO PATHOGENS** | **9** | | |
| | Introduction to pathogens & virulence. Types of pathogens – Prions | 3 | 1 | 1,2 |
| | Bacteria | 2 | 1 | 1,2 |
| | Virus | 2 | 2 | 3 |
| | Protozoa. Virulence factors – Defensive and offensive virulence factors. | 2 | 1 | 1,2 |
| **UNIT II** | **VIRUSES AND VACCINES** | **9** | | |

| | | | | |
|---|---|---|---|---|
| | DNA viruses and RNA viral diseases | 3 | 2 | 3 |
| | Mechanisms of replication. | 3 | 2 | 3 |
| | Retroviruses: Molecular biology of HIV | 2 | 2 | 3 |
| | Antiviral therapy. Viral vaccines strategies and antiviral drug therapy. | 1 | 2 | 3 |
| **UNIT III** | **NEUROLOGICAL DISORDERS** | **9** | | |
| | Introduction to neurological disorders - Kuru | 1 | 3 | 1,2 |
| | Scrapie | 1 | 3 | 1,2 |
| | Creutzfeldt-Jakob disease | 1 | 3 | 1,2 |
| | Mad cow disease | 1 | 3 | 1,2 |
| | Alzheimer's disease | 1 | 3 | 1,2 |
| | Multiple sclerosis | 1 | 3 | 1,2 |
| | Parkinson's disease | 1 | 3,5 | 1,2 |
| | Huntington's disease | 1 | 3, 4 | 1,2 |
| | Degenerative diseases of motor neurons. | 1 | 3 | 1,2 |
| **UNIT IV** | **GENETIC DISORDERS** | **9** | | |
| | Introduction to Genetic disorders. Types of genetic disorders - Single gene inheritance (cystic fibrosis) | 2 | 4, 5 | 1,2 |
| | Sickle cell anemia | 1 | 4 | 1,2 |
| | Multifactorial inheritance (heart disease high blood pressure diabetes) | 2 | 4 | 1,2 |
| | Chromosome abnormalities (Down syndrome, Turner syndrome) | 2 | 4 | 1,2 |
| | Mitochondrial inheritance (myoclonic epilepsy, Leber's hereditary optic atrophy). | 2 | 4 | 1,2 |
| **UNIT V** | **AGING AND ASSOCIATED DISORDERS** | **9** | | |
| | Introduction to Aging and Disease; Causes of aging – 'wear and tear' theories & Genome-based theories. Age related diseases- Cancer | 1.5 | 5 | 1,2 |
| | Cardiovascular Disease | 1.5 | 5 | 1,2 |
| | Diabetes Mellitus Type 2 | 1.5 | 5 | 1,2 |
| | Cataracts | 1.5 | 5 | 1,2 |
| | Arthritis | 1.5 | 5 | 1,2 |
| | Parkinson's Disease. Calorie Restriction and Aging. | 1.5 | 4, 5 | 1,2 |
| | **Total** | **45 hours** | | |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| | **Program Learning Outcomes (PLO)** |
|---|---|

| CLOs | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Life Long Learning | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | | 3 | 3 | | 3 | | 2 | 3 | 1 | 3 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | | 2 | | | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | | | | | 3 | | 2 | 3 | 3 | 2 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 1 | | | | 3 | | 3 | 3 | 3 | 3 |
| Outcome 5 | 3 | 2 | 3 | 3 | 2 | | | 3 | | | | 2 | 3 | 2 | 2 |
| **Course Average** | **3** | **2.2** | **3** | **3** | **2.2** | **1** | **2.5** | **3** | | **3** | | **2.2** | **3** | **2.2** | **2.6** |

**Course Unitization Plan**

**Recommended Resources**

**TEXTBOOKS**


1. Ahmed, N., Dawson, M., Smith, C., & Wood, E. (2006). Biology of disease. Garland Science.
2. Crowley, L. (2011). Essentials of human disease. Jones & Bartlett Publishers.
3. Acheson, N. H. (2011). Fundamentals of molecular virology (No. Ed. 2). John Wiley & Sons, Inc.


**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | End Semester Exam (50%) |
|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | Mid-1 (15%) | CLA-2 (10%) | CLA-3 (15%) | |
| | | Th | Th | Th | Th | Th |
| Level 1 | Remember | 100% | 100% | 100% | 100% | 100% |
| | Understand | | | | | |
| Level 2 | Apply | | | | | |
| | Analyse | | | | | |
| Level 3 | Evaluate | | | | | |
| | Create | | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** | **100%** |


*Course Designer:*

*Prof. Jayaseelan Murugaiyan, Department of Biological Sciences, SRM University-Andhra Pradesh*

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

# BIOINFORMATICS LAB

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | **BIO 310** | Course Category | **Core Course (CC)** | L-T-P-C | **0** | **0** | **2** | **2** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** To comprehend the basics of biological data base and Bioinformatics.
**Objective 2:** To gain expertise in UNIPROT Nucleic acid sequence databank – Gene bank, EMBL, DDBJ
**Objective 3:** To enable students to preform BLAST, FASTA Pair wise alignment.
**Objective 4:** To enable students to evaluate protein structure by Swiss PDB and visualization tools – RASMO.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Demonstrate the principle of biological database and internet resources in Bioinformatics. | 3 | 80% | 70% |
| **Outcome 2** | Explain the UNIPROT Nucleic acid sequence databank – Gene bank, EMBL, DDBJ | 5 | 80% | 70% |
| **Outcome 3** | Demonstrate the Waterman algorithms Multiple alignment-LUSTALW, CLUSTAL X and T-COFFEE. | 3 | 80% | 70% |
| **Outcome 4** | Demonstrate the protein structure Swiss PDB viewer and visualizat tools –RASMOL and Homol modelling of a protein sequence. | 3 | 70% | 65% |

## Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

| | **Program Learning Outcomes (PLO)** |
|---|---|

| CLOs | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Life long Learning | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 2 | 3 | 3 | 3 | 2 | | | 3 | 3 | | 2 | 3 | 3 | 3 |
| Outcome 2 | 3 | 2 | 3 | 3 | 3 | 2 | | | 3 | | | 2 | 3 | 2 | 2 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | 2 | | | 3 | 3 | | 1 | 3 | 3 | 2 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 2 | | | 3 | 3 | | 2 | 3 | 3 | 2 |
| **Course Average** | **3** | **2.3** | **3** | **3** | **3** | **2** | | | **3** | **3** | | **1.8** | **3** | **2.8** | **2.3** |

**Course Unitization Plan – Lab**

| Exp No. | Experiment Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| 1. | Homology Modeling | 6 | 1,2 | 1, 2, 3 |

| | | | | |
|---|---|---|---|---|
| 2. | Molecular Docking | 6 | 1,4 | 1, 2, 3 |
| 3. | Molecular Dynamics Simulations | 6 | 1,4 | 1, 2, 3 |
| 4. | Molecular interaction analysis | 6 | 1 | 1, 2, 3 |
| 5. | Automation of analysis pipeline | 6 | 1 | 1, 2, 3 |
| 6. | SwissDock and SwissModel | 6 | 2, 3 | 1, 2, 3 |
| 7. | NCBI Database | 6 | 2, 3 | 1, 2, 3 |
| 8. | Genome browsers | 6 | 2, 3 | 1, 2, 3 |
| 9. | Torsion angle calculation using Python programming | 6 | 4 | 1, 2, 3 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources:**

**1**. "Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools" by Supratim Choudhuri:

**2.** "Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and Pavel Pevzner:

**3.** "Bioinformatics: Sequence and Structure Analysis" by Michael Gribskov and John Devereux:

**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | **End Semester Exam (50%)** |
|---|---|---|---|---|---|
| | | **Experiments (20%)** | **Record / Observation Note (10%)** | **Viva + Model (20%)** | |
| Level 1 | Remember | | | | |
| | Understand | | | | |
| Level 2 | Apply | 50% | 100% | 50% | 50% |
| | Analyse | | | | |
| Level 3 | Evaluate | 50% | | 50% | 50% |
| | Create | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** |

**Course Designers:**

*Dr. Naga Bhushana Rao Karampudi, Assistant Professor, Department of Biological Sciences, SRM University-Andhra Pradesh*

## Course Name: Career Skills for Lifesciences-II

| Course Code | | Course Category | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | |
| Course Offering Department | | Professional / Licensing Standards | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

- Develop advanced research skills in experimental design, data analysis, and bioinformatics for independent project execution.
- Enhance scientific communication through grant writing, manuscript preparation, and intellectual property awareness.
- Explore diverse career pathways and create actionable plans for transitioning across academia, industry, and entrepreneurship.
- Cultivate leadership, collaboration, and global networking skills for professional and research success.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | At the end of the course the learner will be able to | Bloom's Level | Expected Proficiency Percentage | Expected Attainment Percentage |
|---|---|---|---|---|
| **Outcome 1** | Apply advanced research techniques and bioinformatics tools to design and analyze complex datasets. | **3** | **85%** | **755** |
| **Outcome 2** | Create compelling scientific documents, including grant proposals and manuscripts, with proficiency in scientific communication. | **4** | **80%** | **70%** |
| **Outcome 3** | Identify and plan career pathways in academia, industry, and interdisciplinary fields with a tailored action plan. | **4** | **75%** | **70%** |
| **Outcome 4** | Demonstrate leadership and collaboration skills in managing research teams and fostering ethical partnerships. | **3** | **75%** | **70%** |
| **Outcome 5** | Navigate global opportunities and entrepreneurial ventures through fellowship applications, startup planning, and professional networking. | **3** | **75%** | **70%** |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO 1 | PSO 2 | PSO 3 |
| **Outcome 1** | 3 | 3 | 2 | 2 | 3 | 3 | 1 | | 1 | 2 | 1 | 2 | **1** | **1** | **3** |
| **Outcome 2** | 3 | 2 | 3 | 2 | 2 | 2 | | 1 | 2 | 3 | 1 | 3 | **1** | **1** | **3** |
| **Outcome 3** | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 3 | **1** | **1** | **3** |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Outcome 4** | 2 | 1 | 2 | 1 | 1 | 1 | **1** | **2** | 3 | 2 | 3 | 2 | **2** | **1** | **3** |
| **Outcome 5** | 3 | 2 | 2 | 2 | 2 | 3 | **1** | 1 | 2 | 3 | 3 | 2 | **2** | **1** | **3** |
| **Average** | **3** | **1** | **2** | **2** | **2** | **2** | **1** | **1** | **2** | **2** | **2** | **2** | **1** | **1** | **3** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| **1** | **Advanced Research Skills** | **12** | 1 | |
| | Designing high-impact experiments and studies. | 4 | 1 | 1,2,3 |
| | Data visualization and analysis using R and Python. | 4 | 1 | 1,2,3 |
| | Exploring advanced bioinformatics tools (e.g., BLAST, Galaxy, STRING). | 4 | 1 | 1,2,3 |
| **2** | **Scientific Communication and Writing** | **10** | 2 | 4 |
| | Writing compelling grant and fellowship proposals. | 3 | 2 | 4 |
| | Preparing manuscripts for high-impact journals. | 3 | 2 | 4 |
| | Drafting and presenting review articles. | 2 | 2 | 4 |
| | Intellectual property basics: Patents and copyrighting scientific ideas. | 2 | 2 | 4 |
| **3** | **Career Pathways and Transitioning** | **8** | 3 | |
| | Exploring industry roles: Biotech, pharma, and environmental consulting. | 2 | 3 | 5 |
| | Understanding interdisciplinary fields: Bioinformatics, biophysics, and bioengineering. | 2 | 3 | 5 |
| | Navigating academia: Postdoctoral positions, academic job markets, and tenure tracks. | 2 | 3 | 5 |
| | Networking and mentorship: Strategies for success. | 2 | 3 | 5 |
| **4** | **Leadership and Collaboration in Science** | **8** | 4 | |
| | Building and managing research teams. | 2 | 4 | 5 |
| | Effective mentorship: Skills for guiding peers and students. | 2 | 4 | 5 |
| | Strategies for successful collaborations: Industry-academia partnerships. | 2 | 4 | 5 |
| | Ethics in collaborative science and publishing. | 2 | 4 | 5 |
| **5** | **Global and Entrepreneurial Opportunities** | **7** | 5 | |
| | Applying for international fellowships and scholarships (e.g., Fulbright, Marie Curie). | 2 | 5 | 6 |

| | | | | |
|---|---|---|---|---|
| | Preparing for global collaborations and fieldwork. | 1 | 5 | 6 |
| | Basics of launching a biotech startup. | 2 | 5 | 6 |
| | Preparing business proposals and pitches. | 1 | 5 | 6 |
| | Building a strong online presence: LinkedIn, ORCID, and personal websites. | 1 | 5 | 6 |
| | Total Contact Hours | 45 | | |

**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (100%) | | | |
|---|---|---|---|---|---|
| | | CLA-1 25% | Mid-1 25% | CLA-2 25% | CLA-3 25% |
| Level 1 | Remember | 20 | 30 | 20 | 20 |
| | Understand | | | | |
| Level 2 | Apply | 80 | 70 | 80 | 80 |
| | Analyse | | | | |
| Level 3 | Evaluate | | | | |
| | Create | | | | |
| Total | | | | | |

**Recommended Resources**


1. Bioinformatics portals (NCBI, Ensembl).
2. Data analysis platforms (Jupyter Notebook, RStudio).
3. McKinney, W. (2017). *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython* (2nd ed.). O'Reilly Media. ISBN: 978-1491957660.
4. Schimel, J. (2012). *Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded*. Oxford University Press. ISBN: 978-0199760237.
5. Networking platforms (LinkedIn, ResearchGate).
6. Ries, E. (2011). *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. Crown Business. ISBN: 978-0307887894.


**Course Designers**


**2.** Dr. Writoban Basu Ball, Assistant Professor, Dept. of Biological Sciences, SRM University-AP.

# SEMESTER 7

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

# Minor Research Project

| Course Code | **BIO 401** | Course Category | **Dissertation / Project (P)** | L-T-P-C | **0** | **0** | **5** | **5** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** Equip students with essential research methodologies and practical experience in experimental design, data collection, analysis, and interpretation in a biological context.
**Objective 2:** Promote the integration of concepts from various biological disciplines to address complex biological questions and foster a holistic understanding of biology.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Design and execute a minor research project, demonstrating the ability to independently formulate hypotheses, conduct experiments, and analyze data. | 3 | 75% | 70% |
| **Outcome 2** | Analyze and interpret experimental data, using appropriate scientific methods and tools. | 4 | 75% | 70% |
| **Outcome 3** | Effectively present research findings through written reports and oral presentations, demonstrating clear and concise scientific communication skills.. | 4 | 75% | 70% |

## Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Life Long Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 3 | 3 | 3 | 3 | 1 | | | 2 | | | 3 | 3 | 1 | 3 |
| Outcome 2 | 3 | 3 | 3 | 3 | 3 | 2 | | | 2 | | | 3 | 3 | 2 | 2 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | 2 | | | 2 | | | 3 | 3 | 2 | 2 |
| **Course Average** | **3** | **3** | **3** | **3** | **3** | **2** | | | **3** | | | **3** | **3** | **1.8** | **2.2** |

## Course Unitization Plan

| Unit No. | Unit Name | Required Contact hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| Unit 1 | Overview of research design, hypothesis formulation, and experimental planning. | 10 | 1 | 1-7 |
| Unit 2 | Conducting literature review and developing a research proposal. | 20 | 1 | |
| Unit 3 | Designing and conducting experiments, collecting data. | 70 | 1 | |
| Unit 4 | Analyzing and interpreting data using statistical and bioinformatics tools. | 20 | 2 | |
| Unit 5 | Applying interdisciplinary knowledge to analyze findings. | 10 | 2 | |
| Unit 6 | Writing a detailed research report. | 10 | 3 | |
| Unit 7 | Preparing and delivering an oral presentation, defending research findings. | 10 | 3 | |
| **Total Contact Hours** | | **150** | | |

**Recommended Resources**

1. As recommended by the Advisor pertaining to student research interest.
2. https://pubmed.ncbi.nlm.nih.gov/
3. https://www.sciencedirect.com/
4. www.springer.com
5. https://onlinelibrary.wiley.com/
6. Research Methodology
7. Reading assignment related to undergraduate project as guided by faculty

## Learning Assessment

| Bloom's Level of Cognitive Task | | Record / Observation Note (50%) | Presentation (50%) |
|---|---|---|---|
| Level 1 | Remember | 50% | 20% |
| | Understand | | |
| Level 2 | Apply | 50% | 80% |
| | Analyse | | |
| Level 3 | Evaluate | | |
| | Create | | |
| **Total** | | **100%** | **100%** |

## Course Designers

1. *Dr. Writoban Basu Ball, Assistant Professor, Department of Biological Sciences. SRM University - AP*

# SRM University – AP, Andhra Pradesh

Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

# Signal transduction

| Course Code | **BIO 402** | Course Category | **Core Elective** | L-T-P-C | **4** | **0** | **0** | **4** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |
| Board of Studies Approval Date | | Academic Council Approval Date | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

**Objective 1:** Equip students with knowledge of different types of signaling, receptors, and secondary messengers.
**Objective 2:** Provide insights into cell cycle regulation and cancer-related signaling mechanisms.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Understand the basics of cell signaling, including the types of signaling and the roles of receptors and ligands.. | 2 | 80% | 75% |
| **Outcome 2** | Explain the structure and function of GPCRs and RTKs, and the modulation of their signaling pathways. | 3 | 80% | 70% |
| **Outcome 3** | Describe the role of secondary messengers and specific signaling mechanisms in bacteria and plants. | 2 | 80% | 70% |
| **Outcome 4** | Understand the function of nuclear receptors and the role of transcription factors in gene regulation. | 2 | 70% | 65% |
| **Outcome 5** | Explain the signaling pathways involved in cell cycle regulation and their implications in cancer development. | 3 | 70% | 65% |

**Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)**

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | | 2 | 3 | 1 | 2 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | | 1 | | | 2 | 3 | 2 | 2 |
| Outcome 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | | 1 | | | 2 | 3 | 2 | 2 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | | 1 | | | 2 | 3 | 2 | 2 |
| Outcome 5 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | | 2 | | | 3 | 3 | 2 | 2 |
| **Course Average** | **3** | **2** | **3** | **3** | **2.4** | **1.4** | **2.8** | **3** | **1.6** | **3** | | **2.2** | **3** | **1.8** | **2** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **INTRODUCTION TO SIGNAL TRANSDUCTION** | **10** | | |
| | Overview of Cell Signalling: Definition and importance of cell signalling | 1 | 1 | 1,2,3 |
| | Types of signalling | 1 | 1 | 1,2,3 |
| | Autocrine, paracrine, endocrine, and direct cell-to-cell signalling; | 1 | 1 | 1,2,3 |
| | Molecular Components of Signalling Pathways | 2 | 1 | 1,2,3 |
| | Receptors: types, membrane-bound and intracellular receptors | 1 | 1 | 1,2,3 |
| | Ligands: hormones | 1 | 1 | 1,2,3 |
| | Growth factors, neurotransmitters. | 1 | 1 | 1,2,3 |
| | Intracellular signalling molecules | 1 | 1 | 1,2,3 |
| | Second messengers. | 1 | 1 | 1,2,3 |
| **Unit 2** | **CELL SURFACE RECEPTORS AND INTRACELLULAR SIGNALLING PATHWAYS** | **15** | | |
| | G Protein-Coupled Receptors (GPCRs): Structure and function of GPCRs | 2 | 1,2 | 1,2,3 |
| | GPCR signalling cascades and their modulation. Receptor Tyrosine Kinases (RTKs) | 3 | 1,2 | 1,2,3 |
| | Structure and activation of RTKs. | 2 | 1,2 | 1,2,3 |
| | Downstream signalling pathways of RTKs. | 2 | 1,2 | 1,2,3 |
| | Crosstalk Between Signalling Pathways. | 2 | 1,2 | 1,2,3 |
| | Ion Channel Receptors: Signalling through ligand-gated ion channels | 2 | 1,2 | 1,2,3 |

| | | | | |
|---|---|---|---|---|
| | Role of ion channels in cellular responses. | 2 | 1,2 | 1,2,3 |
| **Unit 3** | **SECONDARY MESSANGERs & CELL SIGNALLING IN BACTERIA & PLANTS** | **10** | | |
| | Secondary messengers-cAMP, cGMP | 2 | 3 | 1,2,3 |
| | Metabolic pathways for the formation of inositol triphosphate from phosphatidyl inositol diphosphate | 3 | 3 | 1,2,3 |
| | $Ca^{2+}$, DAG and NO as signalling molecules. | 2 | 3 | 1,2,3 |
| | Cell signalling in bacteria-Two component system, Quorum sensing, | 2 | 3 | 1,2,3 |
| | Cell signalling in plants | 1 | 3 | 1,2,3 |
| **Unit 4** | **NUCLEAR RECEPTORS AND GENE REGULATION** | **10** | | |
| | Nuclear Receptors: Structure and function of nuclear receptors | 2 | 4 | 1,2,3 |
| | Hormone response elements and gene regulation. | 2 | 4 | 1,2,3 |
| | Transcription Factors in Signalling: | 2 | 4 | 1,2,3 |
| | Role of transcription factors in signal transduction. | 2 | 4 | 1,2,3 |
| | Gene expression changes in response to signalling. | 2 | 4 | 1,2,3 |
| **Unit 5** | **SIGNALLING MECHANISM IN CELL CYCLE REGULATION & CANCER** | **15** | | |
| | Overview of cell cycle and its regulation, | 2 | 5 | 1,2,3 |
| | Cyclin-dependent protein kinases (CDKs) phosphatases, | 3 | 5 | 1,2,3 |
| | DNA damage check points in cell cycle | 2 | 5 | 1,2,3 |
| | Cancer, signal transduction involved in tumerogenesis, | 2 | 5 | 1,2,3 |
| | Oncogenes, proto-oncogenes and tumor suppressor genes. | 2 | 5 | 1,2,3 |
| | Tumor suppressor protein | 2 | 5 | 1,2,3 |
| | p53 and its role in tumor suppression. | 2 | 5 | 1,2,3 |
| **Total Contact Hours** | | **60** | | |

**Recommended Resources**


1. Bruce Alberts, Molecular Biology of the Cell, Garland Science
2. Lehninger Principles of Biochemistry, D. L. Nelson and M. M. Cox, (2017) 7th edition, W.H. Freeman & Company.
3. Molecular Cell Biology: James E. Darnell, Harvey F. Lodish, David Baltimore:


**Learning Assessment**

| Bloom's Level of Cognitive Task | Continuous Learning Assessments (50%) | | | | End Semester Exam (50%) |
|---|---|---|---|---|---|
| | CLA-1 (10%) | Mid-1 (15%) | CLA-2 (15%) | CLA-3 (10%) | |

| | | Th | Prac | Th | Prac | Th | Prac | Th | Prac | Th | Prac |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Level 1 | Remember | 60% | | 70% | | 70% | | 60% | | 70% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 40% | | 30% | | 30% | | 40% | | 30% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

a. *Dr. Jayaseelan Murugaiyan. Professor & Head. Dept. Of Biological Sciences. SRM University – AP*

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

# INTRODUCTION TO OMICS

| Course Code | **BIO 403** | Course Category | **Core Elective** | L-T-P-C | **4** | **0** | **0** | **4** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |
| Board of Studies Approval Date | | Academic Council Approval Date | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** Equip students with knowledge of genomics, transcriptomics, proteomics, and metabolomics, including their methodologies and applications.
**Objective 2:** Provide skills to analyze and interpret complex biological interactions and integrate diverse omics data.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Understand genomics concepts, sequencing methods, and the impact of the Human Genome Project. | 2 | 70% | 65% |
| **Outcome 2** | Master gene expression measurement techniques and functional enrichment analysis. | 3 | 70% | 65% |
| **Outcome 3** | Learn protein separation techniques and mass spectrometry for protein identification. | 3 | 70% | 65% |
| **Outcome 4** | Understand metabolite identification and pathway analysis using MS and NMR. | 3 | 70% | 65% |
| **Outcome 5** | Analyze biological interactions and integrate diverse omics data. | 3 | 70% | 65% |

## Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | 2 | | | 2 | 3 | 1 | 2 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | | | 2 | 3 | 2 | 2 |
| Outcome 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 1 | | | 2 | 3 | 2 | 2 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 2 | | | 2 | 3 | 2 | 2 |
| Outcome 5 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | | | 3 | 3 | 2 | 2 |
| **Course Average** | **2.8** | **2** | **3** | **3** | **2.4** | **1.4** | **2.8** | **3** | **1.6** | | | **2.2** | **3** | **1.8** | **2** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| **Unit 1** | **Genomics** | **10** | | |
| | Understand fundamental genomics concepts and their biological research applications. | 2 | 1 | 1, 2 |
| | Explore diverse sequencing methods and their applications in sequencing entire genomes | 3 | 1 | 1, 2 |
| | Gain insights into methodologies and applications of GWAS for identifying genetic variations linked to traits or diseases | 2 | 1 | 1, 2 |
| | Examine the historical context, objectives, and the transformative impact of the Human Genome Project on genomic research. | 3 | 1 | 1, 2 |
| **Unit 2** | **Transcriptomics** | **15** | | |
| | Understand the definition of a transcriptome, encompassing alternative splicing, mRNA diversity, and the distinction between gene and transcript expression. | 2 | 2 | 1, 2, 3 |
| | Learn techniques such as Northern blotting, qPCR, microarray, and RNA-Sequencing for precise measurement of gene and transcript expression. | 3 | 2 | 1, 2, 3 |
| | Explore the application of differential expression analysis and its significance in understanding variations in gene and transcript expression. | 4 | 2 | 1, 2 3 |
| | Gain proficiency in functional enrichment analysis using tools like Gene Ontology (GO) and Gene Set Enrichment Analysis (GSEA) to decipher biological insights from transcriptomic data. | 3 | 2 | 1, 2, 3 |

| | | | | |
|---|---|---|---|---|
| | Conduct Transcriptome-wide Association Studies (TWAS) to identify expressed transcripts linked to phenotypic variations, and learn to access transcriptome big data through projects like The Cancer Genome Atlas (TCGA) and Genotype-Tissue Expression (GTEx). | 3 | 2 | 1, 2, 3 |
| **Unit 3** | **Proteomics** | **10** | | |
| | Understand the definition, meaning, and goals of proteomics, focusing on the comprehensive study of proteins in biological systems. | 2 | 3 | 3 |
| | Explore the fundamentals of protein and peptide separation, covering both gel-based and non-gel-based proteomic approaches. | 3 | 3 | 3 |
| | Master techniques like one-dimensional electrophoresis (SDS-PAGE), two-dimensional gel electrophoresis (2D-PAGE), and 2D Differential Gel Electrophoresis (DIGE), alongside various staining methods. Understand the basis of mass spectrometry for protein identification in proteomic studies. | 2 | 3 | 3 |
| | Learn the top-down and bottom-up approaches in proteomics, focusing on applications for both qualitative and quantitative analyses of proteins. | 3 | 3 | 3 |
| **Unit 4** | **Metabolomics** | **10** | | |
| | Metabolomics - Sample processing and metabolite identification by mass spectrometry (MS) | 1 | 4 | 2, 3 |
| | nuclear magnetic resonance (NMR) | 2 | 4 | 2, 3 |
| | Data processing and interpretation for NMR | 2 | 4 | 2, 3 |
| | LC-MS | 2 | 4 | 2, 3 |
| | GC- MS | 1 | 4 | 2, 3 |
| | Pathway analysis | 2 | 4 | 2, 3 |
| **Unit 5** | **Systems Biology** | **15** | | |
| | Explore the classes and biological relevance of diverse biological interactions, understanding their significance in molecular processes. | 2 | 1-5 | 2, 3 |
| | Investigate molecular interactions with a focus on databases, providing a comprehensive overview of the molecular landscape. | 3 | 1-5 | 2, 3 |
| | Understand topological analysis in the context of genetic circuits, unraveling the structural and functional aspects of genetic regulatory networks. | 3 | 1-5 | 2, 3 |
| | Explore methodologies for the seamless integration of diverse omics analyses, fostering a holistic understanding of biological systems. | 3 | 1-5 | 2, 3 |
| | Delve into interactome properties through databases and analyses, elucidating the complexities of biological networks at a systems level. | 4 | 1-5 | 2, 3 |
| | **Total hours** | **60** | | |

| **Recommended Resources** |
|---|

1. 1. Genome, Transcriptome and Proteome Analysis by Alain Bernot. John Wiley & Sons, Ltd
2. Principles of Genome Manipulation and Genomics by S.B. Primrose and R.M. Twyman (7th edition). Blackwell Publishing.
3. Transcriptomics. Virendra Gomase. 2009. VDM Verlag
4. Proteomics: A Comprehensive Study of Proteins. Tanner Perry. 2017. Larsen and Keller Education
5. SYSTEMS BIOLOGY P VSI. Eberhard O. Voit. 2020. OUP Oxford.

**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | | | | | End Semester Exam (50%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | | Mid-1 (15%) | | CLA-2 (10%) | | Mid-2 (15%) | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 40% | | 60% | | 40% | | 60% | | 50% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 60% | | 40% | | 60% | | 40% | | 50% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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## Cancer and Stem Cell Biology

| Course Code | **BIO 403** | Course Category | **Core Elective** | L-T-P-C | **4** | **0** | **0** | **4** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |
| Board of Studies Approval Date | | Academic Council Approval Date | | | | | | |

### Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** Equip students with foundational knowledge of cancer, including key terms, types, and contributing factors.
**Objective 2:** Provide insights into the molecular basis of cancer, focusing on oncogenes, tumor suppressor genes, and therapeutic strategies.

### Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Understand cancer terms, types, and development factors. | 2 | 70% | 65% |
| **Outcome 2** | Identify oncogenes, tumor suppressor genes, and therapeutic strategies. | 3 | 70% | 65% |
| **Outcome 3** | Classify stem cells, explore cancer stem cell roles, and potential therapies. | 3 | 70% | 65% |
| **Outcome 4** | Analyze tumor microenvironment components, angiogenesis, and immunotherapy. | 3 | 70% | 65% |
| **Outcome 5** | Learn diagnostic techniques, address ethical issues, and understand social aspects of cancer care. | 3 | 70% | 65% |

### Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | 2 | | | 2 | 3 | 1 | 3 |
| Outcome 2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | | | 2 | 3 | 2 | 3 |
| Outcome 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 1 | | | 2 | 3 | 2 | 3 |
| Outcome 4 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 2 | | | 2 | 3 | 2 | 3 |
| Outcome 5 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | | | 3 | 3 | 2 | 3 |
| **Course Average** | **2.8** | **2** | **3** | **3** | **2.4** | **1.4** | **2.8** | **3** | **1.6** | | | **2.2** | **3** | **1.8** | **3** |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| **Unit 1** | **Introduction to Cancer Biology** | **10** | | |
| | Define key terms related to cancer biology. Explain the hallmarks of cancer. | 2 | 1 | 1, 2 |
| | Summarize historical developments in cancer research. | 3 | 1 | 1, 2 |
| | Compare and contrast different types of cancer. | 2 | 1 | 1, 2 |
| | Interpret cancer statistics and epidemiological data. | 2 | 1 | 1, 2 |
| | Analyze the factors contributing to cancer development. | 1 | 1 | 1, 2 |
| **Unit 2** | **Cellular and Molecular Basis of Cancer** | **15** | | |
| | Identify oncogenes and tumor suppressor genes. | 2 | 1,2 | 1, 2, 3 |
| | Describe the role of mutations in cancer. | 3 | 1,2 | 1, 2 3 |
| | The implications of genetic testing in cancer. | 2 | 1,2 | 1, 2, 3 |
| | Resistance mechanisms in cancer treatment. | 3 | 1,2 | 1, 2, 3 |
| | Crosstalk Between Signalling Pathways. | 3 | 1,2 | 1, 2, 3 |
| | Targeting signaling pathways as therapeutic strategies. | 2 | 1,2 | 3 |
| **Unit 3** | **Stem Cell Biology and Cancer Stem Cells** | **10** | | |
| | Classify different types of stem cells. | 2 | 3 | 3 |
| | The influence of microenvironments on stem cell behavior. | 3 | 3 | 3 |
| | Characteristics of cancer stem cells. | 2 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| | The role of cancer stem cells in tumor progression. | 2 | 3 | 2, 3 |
| | Potential therapeutic approaches targeting cancer stem cells. | 1 | 3 | 2, 3 |
| **Unit 4** | **Tumor Microenvironment and Immune Response** | **10** | | |
| | Identify components of the tumor microenvironment. | 2 | 4 | 2, 3 |
| | Angiogenesis in the context of tumor growth. | 2 | 4 | 2, 3 |
| | Interactions between cancer cells and stroma. | 2 | 4 | 2, 3 |
| | The mechanisms of immune surveillance and evasion. | 2 | 4 | 2, 3 |
| | Potential of immunotherapies in cancer treatment. | 2 | 4 | 2, 3 |
| **Unit 5** | **Clinical Applications and Ethical Considerations** | **15** | | |
| | Diagnostic techniques and imaging modalities for cancer. | 2 | 1-5 | 2, 3 |
| | Ethical challenges in clinical trials. | 3 | 1-5 | 2, 3 |
| | Social and cultural aspects of cancer care. | 3 | 1-5 | 2, 3 |
| | Ethical considerations in cancer research. | 3 | 1-5 | 2,3 |
| | Principles of ethical conduct in clinical and research settings. | 4 | 1-5 | 2,3 |

**Recommended Resources**


1. Bruce Alberts, Molecular Biology of the Cell, Garland Science
2. Molecular Cell Biology: James E. Darnell, Harvey F. Lodish, David Baltimore:
3. Introduction to Cancer Biology: Robin Hesketh (2023); 2nd edition, Cambridge University Press.


**Learning Assessment**

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | | | | | End Semester Exam (50%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | | Mid-1 (15%) | | CLA-2 (10%) | | Mid-2 (15%) | | | |
| | | Th | Prac | Th | Prac | Th | Prac | Th | Prac | Th | Prac |
| Level 1 | Remember | 40% | | 60% | | 40% | | 60% | | 50% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 60% | | 40% | | 60% | | 40% | | 50% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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# SEMESTER 8

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

# Research Degree Project

| Course Code | **BIO 405** | Course Category | **Dissertation / Project (P)** | L-T-P-C | **0** | **0** | **12** | **12** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** Develop students' ability to independently plan, conduct, and analyze a research project in integrative biology.
**Objective 2:** Encourage students to make meaningful contributions to the field of integrative biology through their research findings and conclusions.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Develop proficiency in designing and conducting research in integrative biology. | 3 | 75% | 70% |
| **Outcome 2** | Master advanced analytical techniques to interpret research data effectively. | 4 | 75% | 70% |
| **Outcome 3** | Demonstrate clear and concise scientific communication through written reports and presentations. | 4 | 75% | 70% |

## Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 3 | | | 3 | 3 | 3 | 3 |
| Outcome 2 | 3 | 3 | 3 | 3 | 3 | 1 | | | 1 | 3 | | 3 | 2 | 2 | 3 |
| Outcome 3 | 3 | 3 | 3 | 3 | 3 | | | 2 | 3 | 3 | | 3 | 3 | 2 | 3 |
| **Course Average** | **3** | **3** | **3** | **3** | **3** | **1** | **2** | **1.5** | **2.3** | **3** | | **3** | **2.6** | **2.3** | **3** |

## Course Unitization Plan

| Unit No. | Unit Name | Required Contact hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| Unit 1 | Develop research questions and objectives, and formulate a detailed proposal. | 40 | 1 | 1-7 |
| Unit 2 | Supervised and independent execution of experiments and data collection. | 250 | 2 | |
| Unit 3 | Analyze data using statistical tools, interpret results, and draw conclusions. | 50 | 2 | |
| Unit 4 | Present findings and defend methodologies during a Q&A session. | 20 | 3 | |
| **Total Contact Hours** | | **360** | | |

**Recommended Resources**

1. As recommended by the Advisor pertaining to student research interest.
2. https://pubmed.ncbi.nlm.nih.gov/
3. https://www.sciencedirect.com/
4. www.springer.com
5. https://onlinelibrary.wiley.com/
6. Research Methodology
7. Reading assignment related to undergraduate project as guided by faculty

## Learning Assessment

| Bloom's Level of Cognitive Task | | Record / Observation Note (50%) | Presentation (50%) |
|---|---|---|---|
| Level 1 | Remember | 50% | 20% |
| | Understand | | |
| Level 2 | Apply | 50% | 80% |
| | Analyse | | |
| Level 3 | Evaluate | | |
| | Create | | |
| **Total** | | **100%** | **100%** |

## Course Designers

1. *Dr. Writoban Basu Ball, Assistant Professor, Department of Biological Sciences. SRM University - AP*

# OPEN ELECTIVES

**SRM University – AP, Andhra Pradesh**
Neerukonda, Mangalagiri Mandal
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# Cell Biology

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | | Course Category | **Minor/Open Elective** | L-T-P/Pr-C | **2** | **1** | **0** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** Provide foundational knowledge of cell theory, types, and cellular organization.

**Objective 2:** Study cell structures, division mechanisms, and cell death processes.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Understand cell theory, origin, evolution, and cell types. | 2 | 70% | 65% |
| **Outcome 2** | Describe cell architecture and membrane function. | 2 | 70% | 65% |
| **Outcome 3** | Explain the structure and function of organelles. | 3 | 70% | 65% |
| **Outcome 4** | Understand cell division processes and regulation. | 3 | 70% | 65% |
| **Outcome 5** | Describe mechanisms of necrosis, senescence, and apoptosis. | 2 | 70% | 65% |

## Course Articulation Matrix (CLO) to (PLO) *For B. A. / B. Sc. / B. Com*

*3 = High, 2 = Medium, 1 = Low*

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 1 | - | 1 | 1 | - | | | | 2 | 1 | - | 1 | - | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 2 | 1 | - | 1 | 1 | - | | | | 2 | 1 | - | 1 | - | - | - |
| Outcome 3 | 1 | - | 1 | 2 | - | | | | 2 | 1 | - | 1 | - | - | - |
| Outcome 4 | 1 | - | 1 | 2 | - | | | | 2 | 2 | - | 1 | - | - | - |
| Outcome 5 | 1 | - | 1 | 2 | - | | | | 2 | 2 | - | 1 | - | - | - |
| **Course Average** | **1** | | **1** | **1.6** | | | | | **2** | **1.4** | | **1** | | | |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| **Unit 1** | Introduction to Cell biology | **11** | | |
| | History of Cell biology | 1 | 1 | 1, 2, 3 |
| | Cell theory; Origin and Evolution of cells | 1 | 1 | 1, 2, 3 |
| | Basic properties of cells; Prokaryotic cells and types (bacteria and archaea) | 3 | 1 | 1, 2, 3 |
| | Eukaryotic cells and types (unicellular and multicellular eukaryotes) | 3 | 1 | 1, 2, 3 |
| | Cellular organization of prokaryotes vs eukaryotes | 3 | 1 | 1, 2, 3 |
| **Unit 2** | **Cell structure and function** | **12** | | |
| | Animal, plant and yeast cells | 3 | 2 | 1, 2, 3 |
| | Cell Membrane architecture, and models of membrane structure and function | 3 | 2 | 1, 2, 3 |
| | Cytoskeleton | 3 | 2 | 1, 2, 3 |
| | Transport across membranes: Passive and Active transport | 3 | 2 | 1, 2, 3 |
| **Unit 3** | **Structure and Function of Cellular Organelles** | **12** | | |

| | | | | |
|---|---|---|---|---|
| | Nucleus | 2 | 2 | 1, 2, 3 |
| | endoplasmic reticulum, Golgi apparatus, lysosomes | 2 | 2 | 1, 2, 3 |
| | Mitochondria – structure and origin | 2 | 2 | 1, 2, 3 |
| | Chloroplast – structure and origin | 2 | 2 | 1, 2, 3 |
| | vacuoles, peroxisomes, glyoxysomes | 2 | 2 | 1, 2, 3 |
| | Membraneless organelles: ribosomes, nucleolus, stress granules | 2 | 2 | 1, 2, 3 |
| **Unit 4** | **Cell division** | **6** | | |
| | Cell division in bacteria: Binary fission | 2 | 3 | 1, 2, 3 |
| | Eukaryotic cell division: Cell cycle and regulation | 2 | 3 | 1, 2, 3 |
| | Meiosis | 2 | 3 | 1, 2, 3 |
| **Unit 5** | **Cell death** | **4** | | |
| | Necrosis | 1 | 4 | 1, 2, 3 |
| | Senescence | 1 | 4 | 1, 2, 3 |
| | Apoptosis, Programmed cell death and their mechanisms. | 2 | 4 | 1, 2, 3 |
| **Total Contact Hours** | | **45** | | |

**Recommended Resources**


1. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, Molecular Cell Biology, W. H. Freeman; 6th edition, 2007.
2. Bruce Alberts, Molecular Biology of the Cell, Garland Science, 5th edition, 2008
3. Cooper, G. M., & Hausman, R. E. (2004). The cell: Molecular approach. Medicinska naklada.


**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (50%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | | **Mid-1 (15%)** | | **CLA-2 (10%)** | | **CLA-3 (15%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 60% | | 60% | | 70% | | 80% | | 70% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 40% | | 40% | | 30% | | 20% | | 30% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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# BASIC MICROBIOLOGY

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | | Course Category | **Open Elective (OE)** | L-T-P-C | **2** | **1** | **0** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** Provide foundational knowledge of microbiology history, key theories, and methods to study microbes.

**Objective 2:** Understand microbial cell anatomy, physiology, pathogenesis, and industrial applications.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Understand microbiology history, theories, and methods. | 2 | 70% | 65% |
| **Outcome 2** | Describe microbial structures and characteristics. | 2 | 70% | 65% |
| **Outcome 3** | Explain growth, metabolism, and genetic transfer in microorganisms. | 2 | 70% | 65% |
| **Outcome 4** | Understand viral and bacterial pathogenesis, antibiotic actions, and resistance. | 3 | 70% | 65% |
| **Outcome 5** | Recognize applications in industry, food microbiology, and environmental bioremediation. | 3 | 70% | 65% |

## Course Articulation Matrix (CLO) to (PLO) *For B. A. / B. Sc. / B. Com*

*3 = High, 2 = Medium, 1 = Low*

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | 1 | - | 1 | 1 | - | | | | 2 | 1 | - | 1 | - | - | - |
| Outcome 2 | 1 | - | 1 | 1 | - | | | | 2 | 1 | - | 1 | - | - | - |
| Outcome 3 | 1 | - | 1 | 2 | - | | | | 2 | 1 | - | 1 | - | - | - |
| Outcome 4 | 1 | - | 1 | 2 | - | | | | 2 | 2 | - | 1 | - | - | - |
| Outcome 5 | 1 | - | 1 | 2 | - | | | | 2 | 2 | - | 1 | - | - | - |
| **Course Average** | **1** | | **1** | **1.6** | | | | | **2** | **1.4** | | **1** | | | |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References Used |
|---|---|---|---|---|
| **Unit 1** | **INTRODUCTION TO MICROBIOLOGY** | **11** | | |
| | History of microbiology, Louis Pasteur-Germ theory of disease, Robert Koch- Koch's postulates; Spontaneous generation vs. biogenesis | 1 | 1 | 1, 2, 3 |
| | Essential methods to study microbes: sterilization and disinfection: Methods of sterilization- physical methods (heat, filtration), radiation and chemical methods; | 5 | 1 | 1, 2, 3 |
| | Principles of microscopy; Important parts of a compou microscope; Fluorescence and electron microscope. | 5 | 1 | 1, 2, 3 |
| **Unit 2** | **ANATOMY OF MICROBIAL CELLS** | **8** | | |
| | Different groups of microorganisms and their general characteristics. Prokaryotic and eukaryotic microorganisms – algae, fungi, protozoa; Viruses; | 2 | 2 | 1, 2, 3 |
| | Ultrastructure of Gram positive and Gram-negative bacterial cell wall, Size, shape and arrangement of bacterial cells; | 2 | 2 | 1, 2, 3 |

| | | | | |
|---|---|---|---|---|
| | Cell membrane, cytoplasmic matrix, pili, capsule, flagella, ribosomes, endospores | 2 | 2 | 1, 2 3 |
| | Archaea: Extreme halophiles, methanoge hyperthermophiles. | 2 | 2 | 1, 2, 3 |
| **Unit 3** | **MICROBIAL PHYSIOLOGY** | **8** | | |
| | Microbial growth, Growth media types - selective and differential media; | 2 | 3 | 1, 2, 3 |
| | Influence of environmental factors for microbial growth; Growth phases and kinetics | 2 | 3 | 1, 2, 3 |
| | Quorum sensing; Biofilm formation; Aerobic and anaerobic respiration; | 2 | 3 | 1, 2, 3 |
| | Fermentation | 1 | 3 | 1, 2, 3 |
| | Transfer of genetic material – transformation, conjugat and transduction. | 1 | 3 | 1, 2, 3 |
| **Unit 4** | **MICROBIAL PATHOGENSIS** | **10** | | |
| | Bacteriophage and its life cycle; Viral pathogenesis | 3 | 4 | 1, 2, 3 |
| | Plasmid and transposable element; | 3 | 4 | 1, 2, 3 |
| | Action of antimicrobial drugs: inhibitors of cell wall synthesis, inhibitors of protein synthesis, inhibitors of nucleic acid synthesis, competitive inhibitors | 2 | 4 | 1, 2, 3 |
| | Antibiotic resistance | 2 | 4 | 1, 2, 3 |
| **Unit 5** | **APPLIED MICROBIOLOGY** | **6** | | |
| | Primary and secondary metabolites; Basics of fermenter design | 1 | 5 | 1, 2, 3 |
| | Microorganism of Industrial use, | 1 | 5 | 1, 2, 3 |
| | Food microbiology – Microorganisms in food, Introduction to probiotics and prebiotics, Food preservation | 2 | 5 | 1, 2, 3 |
| | Environmental microbiology – Bioremediation, Bioleaching, Microbial degradation of textile waste | 2 | 5 | 1, 2, 3 |
| **Total Contact Hours** | | **45** | | |

**Recommended Resources**


1. Microbiology, 6th edition (1993), Pelczar, Chan and Krieg; McGraw Hill International
2. Prescott, Harley, and Klein's Microbiology, 8th edition, (2011), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw Hill International
3. Stainer R. Y., Ingraham. J. L., Wheelis M. J., Painter P. R. (1999). General microbiology. MacMillan Educational Ltd. London


**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | | | | | **End Semester Exam (50%)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | | **Mid-1 (15%)** | | **CLA-2 (10%)** | | **CLA-3 (15%)** | | | |
| | | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** | **Th** | **Prac** |
| Level 1 | Remember | 60% | | 60% | | 70% | | 80% | | 70% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 40% | | 40% | | 30% | | 20% | | 30% | |
| | Analyse | | | | | | | | | | |
| | Evaluate | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Level 3 | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

**Course Designers**

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# Human Physiology

| Course Code | **BIO** | Course Category | **Open Elective /Minor** | L-T-P-C | **2** | **1** | **0** | **3** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | Biomolecules, Cell Biology | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** Understand the fundamental physiological mechanisms and organization of the human body.
**Objective 2:** Comprehend physiological processes in respiration, circulation, renal function, and thermoregulation.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Understand cell structure and homeostasis. | 2 | 80% | 75% |
| **Outcome 2** | Explain neuron function and muscle contraction. | 3 | 70% | 65% |
| **Outcome 3** | Describe endocrine and reproductive systems. | 2 | 70% | 65% |
| **Outcome 4** | Understand respiration and circulation physiology. | 2 | 70% | 65% |
| **Outcome 5** | Comprehend renal function, thermoregulation, and osmoregulation. | 3 | 70% | 65% |

## Course Articulation Matrix (CLO) to (PLO) *For B. A. / B. Sc. / B. Com*

*3 = High, 2 = Medium, 1 = Low*

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 1 | - | 1 | 1 | - | | | | 2 | 1 | - | 1 | - | - | - |
| Outco | 1 | - | 1 | 1 | - | | | | 2 | 1 | - | 1 | - | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| me 2 | | | | | | | | | | | | | | | |
| Outcome 3 | 1 | - | 1 | 2 | - | | | | 2 | 1 | - | 1 | - | - | - |
| Outcome 4 | 1 | - | 1 | 2 | - | | | | 2 | 2 | - | 1 | - | - | - |
| Outcome 5 | 1 | - | 1 | 2 | - | | | | 2 | 2 | - | 1 | - | - | - |
| **Course Average** | **1** | | **1** | **1.6** | | | | | **2** | **1.4** | | **1** | | | |

**Course Articulation Matrix (CLO) to (PLO)** *For B. Tech*

*3 = High, 2 = Medium, 1 = Low*

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineering Knowledge | Problem Analysis | Design and Development | Analysis, Design and Research | Modern Tool and ICT Usage | Society and Multicultural Skills | Environment and Sustainability | Moral, and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Project Management and Finance | Self-Directed and Lifelong Learning | PSO 1 | PSO 2 | PSO 3 |
| Outcome 1 | | | | | | | | | 1 | 1 | | 1 | | | |
| Outcome 2 | | | | 1 | | | | | 1 | 1 | | 1 | | | |
| Outcome 3 | | 1 | | 1 | | | | | 1 | 1 | | 1 | | | |
| Outcome 4 | | | 1 | 2 | | | | | 1 | 2 | | 2 | | | |
| Outco | | | | | | 1 | | 1 | 1 | 2 | | 2 | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| me 5 | | | | | | | | | | | | | | | |
| **Course Average** | | **1** | **1** | **1.3** | | **1** | | **1** | **1** | **1.4** | | **1.4** | | | |

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **INTRODUCTION TO PHYSIOLOGY: THE CELL AND GENERAL PHYSIOLOGY** | **9** | | |
| | Functional organization of the human body and control of the internal environment. | 1 | 1, 2, 5 | 1, 2, 3 |
| | Extracellular fluid—the internal environment. | 1 | 1, 2, 5 | 1, 2, 3 |
| | Homeostatic mechanisms of the major functional systems. | 1 | 1, 5 | 1, 2, 3 |
| | Cells as the living units of the body. | 1 | 1, 2, 5 | 1, 2, 3 |
| | The cell and its functions. | 1 | 1 | 1, 2, 3 |
| | Organization of the cell. | 1 | 1 | 1, 2, 3 |
| | Physical structure of the cell. | 1 | 1 | 1, 2, 3 |
| | Comparison of the animal cell with precellular forms of life. | 1 | 1, 2, 5 | 1, 2, 3 |
| | Functional systems of the cell. | 1 | 1, 2 | 1, 2, 3 |
| **Unit 2** | **NERVOUS SYSTEM AND MUSCULAR SYSTEM** | **10** | | |
| | Structure of neuron, resting membrane potential. | 2 | 1, 2 | 1, 2, 3 |
| | Action potential | 1 | 1, 2 | 1, 2, 3 |
| | Types of synapse, Synaptic transmission. | 2 | 1,2 | 1, 2, 3 |
| | Histology of different types of muscle. | 1 | 2 | 1, 2, 3 |
| | Ultra-structure of skeletal muscle. | 1 | 2 | 1, 2, 3 |
| | Molecular and chemical basis of muscle contraction. | 1 | 2 | 1, 2, 3 |
| | Characteristics of muscle fibre. | 1 | 2,4 | 1, 2, 3 |
| | Neuromuscular junction. | 1 | 2 | 1, 2, 3 |
| **Unit 3** | **ENDOCRINE SYSTEM AND REPRODUCTIVE SYSTEM** | **11** | | |
| | Histology and function of thyroid. | 1 | 1,3,4,5 | 1, 2, 3 |
| | Histology and function of pancreas. | 1 | 1,3,4,5 | 1, 2, 3 |
| | Histology and function of adrenal. | 1 | 1,3,4,5 | 1, 2, 3 |
| | Function of pituitary. | 1 | 1,3,4,5 | 1, 2, 3 |
| | Classification of hormones. | 1 | 1,3,4,5 | 1, 2, 3 |
| | Mechanism of Hormone action. | 1 | 1,3,4,5 | 1, 2, 3 |
| | Signal transduction pathways for Steroidal and Non- steroidal hormones. | 1 | 1,3,4,5 | 1, 2, 3 |

| | | | | |
|---|---|---|---|---|
| | Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary. | 1 | 3,5 | 1, 2, 3 |
| | Placental hormones. | 1 | 3,5 | 1, 2, 3 |
| | Histology of mammalian testis and ovary. | 1 | 3,5 | 1, 2, 3 |
| | Physiology of mammalian reproduction – menstrual and oestrous cycle. | 1 | 3,5 | 1, 2, 3 |
| **Unit 4** | **PHYSIOLOGY OF RESPIRATION AND CIRCULATION** | **10** | | |
| | Mechanism of respiration. | 1 | 1-5 | 1, 2, 3 |
| | Respiratory volumes and capacities. | 1 | 1-5 | 1, 2, 3 |
| | Transport of oxygen and carbon dioxide in blood. | 1 | 1-5 | 1, 2, 3 |
| | Dissociation curves and the factors influencing | 1 | 1-5 | 1, 2, 3 |
| | Respiratory pigments. | 1 | 1-5 | 1, 2, 3 |
| | Carbon monoxide poisoning. | 1 | 1-5 | 1, 2, 3 |
| | Physiology of circulation structure and functions of haemoglobin; | 1 | 1-5 | 1, 2, 3 |
| | Blood clotting system. | 1 | 1-5 | 1, 2, 3 |
| | Haematopoiesis- Basic steps and its regulation. | 1 | 1-5 | 1, 2, 3 |
| | Blood groups- ABO and Rh factor. | 1 | 1-5 | 1, 2, 3 |
| **Unit 5** | **RENAL PHYSIOLOGY, THERMOREGULATION AND OSMOREGULATION** | **5** | | |
| | Structure of Kidney and its functional unit. | 1 | 1,5 | 1, 2, 3 |
| | Mechanism of urine formation. | 1 | 1,5 | 1, 2, 3 |
| | Regulation of acid-base balance. | 1 | 1,5 | 1, 2, 3 |
| | Thermal regulation in camel and polar bear. | 1 | 1,5 | 1, 2, 3 |
| | Osmoregulation in aquatic vertebrates. | 1 | 1,5 | 1, 2, 3 |
| **Total Contact Hours** | | **45** | | |

**Recommended Resources**


1. Guyton and Hall Textbook of Medical Physiology. 2011. John E. Hall. Saunders Elsevier, 12th edition.
2. Ganong's Review of Medical Physiology. 2010. Kim E. Barrett, Scott Boitano, Susan M. Barman, Heddwen L. Brooks. McGrawHill Medical, 23rd edition.
3. Animal Physiology. 2012. Richard W. Hill, Gordon A. Wyse, Margaret Anderson. Sinauer Associates, Inc. Publishers, 3rd edition.


**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | **End Semester Exam (50%)** |
|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | **Mid-1 (15%)** | **CLA-2 (10%)** | **Mid-2 (15%)** | |
| | | **Th** | **Th** | **Th** | **Th** | **Th** |
| Level 1 | Remember | 100% | 80% | 100% | 90% | 90% |
| | Understand | | | | | |
| Level 2 | Apply | | 20% | | 10% | 10% |
| | Analyse | | | | | |
| Level 3 | Evaluate | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Create | | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** | **100%** |

**Course Designers**

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# Molecular Biology

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | | Course Category | Minor/Open Elective | L-T/D-P/Pr-C | 2 | 1 | 0 | 3 |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | Biological Sciences | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** Understand the fundamental mechanisms of gene expression, including transcription, RNA processing, translation, and post-translational modifications.

**Objective 2:** Analyze the regulation of gene expression and the processes involved in DNA replication and repair.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | At the end of the course, the learner will be able to | Bloom's Level | Expected Proficiency Percentage | Expected Attainment Percentage |
|---|---|---|---|---|
| **Outcome 1** | Understand gene structure and transcription mechanisms. | 2 | 70% | 65% |
| **Outcome 2** | Explain RNA processing and modifications. | 2 | 70% | 65% |
| **Outcome 3** | Describe translation and post-translational modifications. | 3 | 70% | 65% |
| **Outcome 4** | Analyze gene regulation mechanisms. | 3 | 70% | 65% |
| **Outcome 5** | Understand DNA replication and repair mechanisms. | 2 | 70% | 65% |

## Course Articulation Matrix (CLO) to (PLO) *For B. A. / B. Sc. / B. Com*

*3 = High, 2 = Medium, 1 = Low*

| CLOs | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO 1 | PSO 2 | PSO 3 |
| Outco | 1 | - | 1 | 1 | - | | | | 2 | 1 | - | 1 | - | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| me 1 | | | | | | | | | | | | | | | |
| Outcome 2 | 1 | - | 1 | 1 | - | | | | 2 | 1 | - | 1 | - | - | - |
| Outcome 3 | 1 | - | 1 | 2 | - | | | | 2 | 1 | - | 1 | - | - | - |
| Outcome 4 | 1 | - | 1 | 2 | - | | | | 2 | 2 | - | 1 | - | - | - |
| Outcome 5 | 1 | - | 1 | 2 | - | | | | 2 | 2 | - | 1 | - | - | - |
| **Course Average** | **1** | | **1** | **1.6** | | | | | **2** | **1.4** | | **1** | | | |

**Course Articulation Matrix (CLO) to (PLO)** *For B. Tech*

*3 = High, 2 = Medium, 1 = Low*

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineering Knowledge | Problem Analysis | Design and Development | Analysis, Design and Research | Modern Tool and ICT Usage | Society and Multicultural Skills | Environment and Sustainability | Moral, and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Project Management and Finance | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | | | | | | | | | 1 | 1 | | 1 | | | |
| Outcome 2 | | | | 1 | | | | | 1 | 1 | | 1 | | | |
| Outcome 3 | | 1 | | 1 | | | | | 1 | 1 | | 1 | | | |
| Outco | | | 1 | 2 | | | | | 1 | 2 | | 2 | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| me 4 | | | | | | | | | | | | | | | |
| Out co me 5 | | | | | | 1 | | 1 | 1 | 2 | | 2 | | | |
| **Co urs e Av era ge** | | **1** | **1** | **1.3** | | **1** | | **1** | **1** | **1.4** | | **1.4** | | | |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| Unit 1 | Gene Expression: Transcription and RNA Processing | 10 | | |
| | RNA world; Origin of DNA and classical experiments proving DNA as genetic material | 1 | 1 | 1,3,4 |
| | Complexity of definition of a gene, | 1 | 1 | 1,2,3 |
| | Prokaryotic and eukaryotic gene structure; | 1 | 1 | 1,2,3 |
| | Types of genes; Prokaryotic and eukaryotic promoters, | 1 | 1 | 3,4 |
| | Mechanism of transcription | 2 | 1 | 3,4 |
| | Types of RNAs | 1 | 1 | 1,2,4 |
| | prokaryotes and eukaryotes structure of rRNA, | 1 | 1 | 1,2,4 |
| | prokaryotes and eukaryotes structure of tRNA, | 1 | 1 | 1,2,4 |
| | prokaryotes and eukaryotes structure of mRNA | 1 | 1 | 1,2,4 |
| Unit 2 | Gene Expression: Post-Transcriptional Processing and Modifications | 8 | | |
| | Processing ribosomal RNAs | 1 | 1 | 1,2,3 |
| | biogenesis and assembly of ribosomal subunits in the nucleolus; | 2 | 1 | 1,2,3 |
| | tRNA processing and modifications | 2 | 2 | 1,2,4 |
| | mRNA-splicing, | 1 | 2 | 1,2,4 |
| | mRNA- modification; | 1 | 2 | 1,2,4 |
| | RNA transport | 1 | 2 | 1,2,4 |
| Unit 3 | Gene Expression: Translation and Post-Translational Modifications | 8 | | |
| | Genetic code, degeneracy and codon bias. | 1 | 3 | 1,2,3 |
| | Ribosome; Structure and Function of the protein synthesis machinery: | 2 | 3 | 1,2,3 |
| | The Ribozyme; Prokaryotic translation: | 1 | 3 | 1,2,3 |

| | | | | |
|---|---|---|---|---|
| | coupled transcription and translation; | 1 | 3 | 1,2,3 |
| | Eukaryotic translation: translational factors, steps in translation: | 2 | 3 | 1,2,3 |
| | Initiation, elongation and termination; Post-translational modification of proteins and protein transport. | 1 | 3 | 1,2,3 |
| Unit 4 | Gene Regulation | 9 | | |
| | Chromatin structure and function; Gene regulation at multiple levels; | 2 | 4 | 2,4 |
| | Transcriptional regulation: activators and repressors, | 2 | 4 | 2,4 |
| | Transcriptional factors and basic transcriptional machinery in eukaryotes; | 1 | 4 | 2,4 |
| | Post-transcriptional regulation of gene expression, Translational & post-translational regulation of gene expression; | 1 | 4 | 2,4 |
| | Regulation of gene expression in prokaryotes using lac operon as a model. | 3 | 4 | 2,4 |
| Unit 5 | DNA Replication and Repair | 10 | | |
| | Meselson and Stahl experiment: Semi-conservative nature of DNA replication. | 2 | 5 | 2,3 |
| | The mechanism of DNA replication: | 2 | 5 | 2,3 |
| | Replication fork, leading and lagging strands, enzymes and proteins involved in replication; | 2 | 5 | 2,3 |
| | The replication process: Initiation, elongation and termination, | 1 | 5 | 2,3 |
| | Proof reading; Replication in prokaryotes and eukaryotes, | 1 | 5 | 2,3 |
| | DNA damage and repair mechanisms, | 1 | 5 | 2,3 |
| | Recombination and repair mechanisms, SOS system | 1 | 5 | 2,3 |
| Total Contact Hours | | 45 | | |

**Recommended Resources**


1. Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter

2014. 6 th edition, Garland Science.

1. Genes VIII. Benjamin Lewin. 8th edition, Pearson.
1. Molecular Biology of the Gene: J.D. Watson, T.A. Baker, S.P. Bell, A.A.F. Gann, M. Levine and

R.M. Losick (2007). 7th edition. Benjamin Cummings.

4. Molecular Cell Biology: H. Lodish, A. Berk, C.A. Kaiser et al (2007) 6th edition. W.H. Freeman


**Learning Assessment**

| | **Continuous Learning Assessments (100%)** |
|---|---|

| Bloom's Level of Cognitive Task | | CLA-1 (20%) | CLA-2 (20%) | CLA-3 (20%) | CLA-4 (20%) | CLA-5 (20%) |
|---|---|---|---|---|---|---|
| Level 1 | Remember | 60 | 70 | 70 | 60 | 70 |
| | Understand | | | | | |
| Level 2 | Apply | 40 | 30 | 30 | 40 | 30 |
| | Analyse | | | | | |
| Level 3 | Evaluate | | | | | |
| | Create | | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** | **100%** |

**Course Designers**

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# Bioinformatics

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | | Course Category | **Core Course (CC)** | L-T-P-C | **2** | **0** | **1** | **3** |
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Biological Sciences** | Professional / Licensing Standards | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

**Objective 1:** Understand the fundamental concepts and tools of bioinformatics for analyzing biological data.

**Objective 2:** Apply bioinformatics techniques and web-resources to model proteins and analyze genomic data.

## Course Outcomes / Course Learning Outcomes (CLOs)

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Describe the molecular nature of biological systems | 1 | 80% | 75% |
| **Outcome 2** | Demonstrate the utilization of available resources of biological databases | 2 | 85% | 80% |
| **Outcome 3** | Explain and identify the inter-relationships between biological molecules like DNA, RNA and Protein | 3 | 70% | 60% |
| **Outcome 4** | Identify and incorporate web-resources in bioinformatics analysis. | 3 | 70% | 65% |

**Course Articulation Matrix (CLO) to (PLO)** *For B. A. / B. Sc. / B. Com*
*3 = High, 2 = Medium, 1 = Low*

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scientific and Disciplinary Knowledge | Analytical Reasoning and Problem Solving | Critical and Reflective Thinking | Scientific Reasoning and Design Thinking | Research Related Skills | Modern Tools and ICT Usage | Environment and Sustainability | Moral, Multicultural and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Leadership Readiness Skills | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | 1 | 1 | 2 | 1 | | | | | 2 | 1 | | 1 | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 2 | 1 | 1 | 2 | 1 | | 2 | | | 2 | 2 | | 2 | | | |
| Outcome 3 | 1 | | 2 | 1 | | | | | 2 | 1 | | 1 | | | |
| Outcome 4 | 1 | 1 | 2 | 2 | | 2 | | | 3 | 2 | | 3 | | | |
| **Course Average** | **1** | **1** | **2** | **1.2** | | **2** | | | **2.2** | **1.5** | | **1.7** | | | |

**Course Articulation Matrix (CLO) to (PLO)** *For B. Tech*
*3 = High, 2 = Medium, 1 = Low*

| **CLOs** | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineering Knowledge | Problem Analysis | Design and Development | Analysis, Design and Research | Modern Tool and ICT Usage | Society and Multicultural Skills | Environment and Sustainability | Moral, and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Project Management and Finance | Self-Directed and Lifelong Learning | PSO1 | PSO2 | PSO3 |
| Outcome 1 | | | | | | | | | 1 | 1 | | 1 | | | |
| Outcome 2 | | 2 | 1 | 1 | 2 | | | | 2 | 2 | | 2 | | | |
| Outcome 3 | | | | | | | | | 1 | 1 | | 1 | | | |
| Outcome 4 | | 3 | 2 | 2 | 2 | | | | 2 | 2 | | 2 | | | |
| **Course Average** | | **2.5** | **1.5** | **1.5** | **2** | | | | **1.5** | **1.5** | | **1.5** | | | |

**Course Unitization Plan**

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | Fundamentals of Bioinformatics | **6+6** | | |
| | Organization and hierarchy in biological Systems | 2 | 1 | 1, 2 |
| | Information Flow | 1 | 1 | 1, 2 |
| | Digitization of biological data and their availability | 2 | 1 | 1, 2 |
| | File Formats | 1 | 1 | 1, 2 |
| | Practical: Parsing File formats | **6** | | |
| **Unit 2** | **Protein** | **8+8** | | |
| | Sequence and structure | 2 | 1, 2 | 1, 2, 3 |
| | Protein folding | 2 | 1, 2 | 1, 2, 4 |
| | Molecular Visualizer | 1 | 1, 2 | 1, 2, 4 |
| | Homology Modeling | 1 | 2,3 | 2,3 |
| | Docking | 1 | 2,3 | 2,3 |
| | Molecular Dynamics Simulations | 1 | 2,3 | 1,2,5 |
| | Practical: Molecular visualization, Homology Modeling, Docking, MD Simulations. | **8** | | |
| **Unit 3** | **Nucleic Acid** | 6+6 | | |
| | DNA, RNA | 1 | 1, 3 | 2, 3 |
| | Sequence and Structure | 1 | 1, 3 | 2, 3 |
| | Sequence alignment | 2 | 1, 2, 3 | 2, 3, 4 |
| | Transcriptome | 1 | 1, 2 | 1, 2 |
| | Genome and their data analysis | 1 | 1, 2, 3 | 1, 2, 4 |
| | Practical: Sequence alignment, Transcriptome data analysis | **6** | | |
| **Unit 4** | **Evolution** | **6+6** | | |
| | Evolutionary models | 2 | 1, 3, 4 | 2, 3 |
| | Homology | 2 | 1, 3, 4 | 2, 4 |
| | Phylogenetic trees | 1 | 1, 3, 4 | 3, 4 |
| | Synteny analysis | 1 | 1, 4 | 1, 2, 3 |
| | Practical: Phylogenetic tree construction, Synteny analysis | **6** | | |
| **Unit 5** | Web-Resources | **4+4** | | |
| | NCBI, RCSB, Ensembl, KEGG, CANSAR | 2 | 1, 3, 4 | 2, 4 |
| | SwissDock, UniProt, String-DB, Genemania | 1 | 1, 2, 4 | 2, 3, 4 |
| | MINT (Molecular Interaction Database), Catalytic Site Atlas (CSA), ChEmbl | 1 | 1, 3, 4 | 1, 3, 4 |
| | Practical: NCBI, RCSB, KEGG, MINT, CSA | **4** | | |
| **Total Contact hours** | | **(Theory + Practical) 30+30** | | |

**Recommended Resources**


1. Bioinformatics: An Introductory Textbook. Thomas .D., Meik .K., (2023) Springer. ISBN: 978-3-662-65035-6
2. Protein Bioinformatics: From Sequence to Function. Gromiha .M., (2010) Academic Press. ISBN: 978-81-312-2297-3
3. Applied bioinformatics. Selzer .P., Marhofer .R., Koch .O., 2nd edition (2018), Springer. ISBN: 9783319683010
4. Bioinformatics Database Systems. Byron .K, Herbert .K., and Wang .J., (2016), CRC Press. ISBN: 9781315388090
5. Biomolecular simulations in structure based drug discovery. Gervasio .F., and Spiwok .V., (2019) Wiley. ISBN: 9783527806850


## Learning Assessment

| Bloom's Level of Cognitive Task | | Continuous Learning Assessments (50%) | | | | | | | | End Semester Exam (50%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA-1 (10%) | | Mid-1 (15%) | | CLA-2 (10%) | | Mid-2 (15%) | | | |
| | | Th | Prac | Th | Prac | Th | Prac | Th | Prac | Th | Prac |
| Level 1 | Remember | 40% | | 60% | | 60% | | 50% | | 70% | |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | 60% | | 40% | | 40% | | 50% | | 30% | |
| | Analyse | | | | | | | | | | |
| Level 3 | Evaluate | | | | | | | | | | |
| | Create | | | | | | | | | | |
| **Total** | | **100%** | | **100%** | | **100%** | | **100%** | | **100%** | |

## Course Designers

1. Dr. Naga Bhushana Rao Karampudi, Assistant Professor, Department of Biological Sciences.

**SRM University – AP, Andhra Pradesh**

Neerukonda, Mangalagiri Mandal

Guntur District, Mangalagiri, Andhra Pradesh 522240

**Introductory Biology**

| Course Code | **BIO 102** | Course Category | **Core Course (CC)** | L-T-P-C | **3** | **0** | **0** | **3** |
|---|---|---|---|---|---|---|---|---|
| Pre-Requisite Course(s) | | Co-Requisite Course(s) | | Progressive Course(s) | | | | |
| Course Offering Department | **Department of Biological Sciences** | Professional / Licensing Standards | | | | | | |

**Course Objectives / Course Learning Rationales (CLRs)**

**Objective 1:** Develop a comprehensive understanding of the structure and function of biomolecules, cells, and their roles in life's diversity and biological processes.

**Objective 2:** Understand molecular biology mechanisms, gain insights into human physiology and understand and utilize biological databases.

**Course Outcomes / Course Learning Outcomes (CLOs)**

| | **At the end of the course, the learner will be able to** | **Bloom's Level** | **Expected Proficiency Percentage** | **Expected Attainment Percentage** |
|---|---|---|---|---|
| **Outcome 1** | Understand biomolecules: carbohydrates, lipids, proteins, nucleic acids, vitamins, and minerals. | 2 | 80% | 75% |
| **Outcome 2** | Describe cell structure, diversity, and cellular processes. | 2 | 80% | 70% |
| **Outcome 3** | Explain DNA structure, replication, transcription, translation, and cell division. | 2 | 80% | 70% |
| **Outcome 4** | Understand human body systems: immune, digestive, respiratory, endocrine, nervous, and sensory. | 2 | 75% | 70% |
| **Outcome 5** | Use biological databases and analyze genomic and proteomic data. | 3 | 75% | 70% |

**Course Articulation Matrix (CLO) to (PLO)** *For B. Tech*

*3 = High, 2 = Medium, 1 = Low*

| CLOs | Program Learning Outcomes (PLO) |
|---|---|

| | Engineering Knowledge | Problem Analysis | Design and Development | Analysis, Design and Research | Modern Tool and ICT Usage | Society and Multicultural Skills | Environment and Sustainability | Moral, and Ethical Awareness | Individual and Teamwork Skills | Communication Skills | Project Management and Finance | Self-Directed and Lifelong Learning | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome 1 | | | | | | | | | | 1 | | 1 | | | |
| Outcome 2 | | | | | | | | | | 1 | | 1 | | | |
| Outcome 3 | | | | | | | | | | 1 | | 1 | | | |
| Outcome 4 | | | | 1 | | | | | | 2 | | 1 | | | |
| Outcome 5 | | 1 | 1 | 2 | 1 | | | | 2 | 2 | | 2 | | | |
| **Course Average** | | **1** | **1** | **1.5** | **1** | | | | **2** | **1.4** | | **1.2** | | | |

| Unit No. | Unit Name | Required Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| **Unit 1** | **Biomolecules** | **9** | | |
| | Why study Biology? | 1 | 1 | 1, 2, 3 |
| | Life on Earth and Evolution | 2 | 1 | 1, 2, 3 |
| | Biomolecules - carbohydrates | 1 | 1 | 1, 2, 3 |
| | Biomolecules - lipids and fats | 1 | 1 | 1, 2, 3 |
| | Biomolecules – proteins | 2 | 1 | 1, 2, 3 |
| | Biomolecules – nucleic acids, vitamins and minerals | 2 | 1 | 1, 2, 3 |
| **Unit 2** | **Cell Biology** | **11** | | |
| | Diversity of life, concept of unicellular and multicellular organisms | 2 | 2 | 1, 2, 3 |
| | Prokaryotic cell structure, Eukaryotic cell (Animal and Plant) - structure and functions of organelles | 3 | 2 | 1, 2, 3 |
| | Diversity of life: virus, bacteria, archaea and eukarya | 2 | 2 | 1, 2, 3 |
| | Membrane transport | 1 | 2 | 1, 2, 3 |
| | Cellular respiration and energy generation | 2 | 2 | 1, 2, 3 |
| | Brief account of Photosynthesis | 1 | 2 | 1, 2, 3 |
| **Unit 3** | **Molecular Biology** | **9** | | |
| | DNA and Chromosomes: structure and organization | 1 | 3 | 1, 2, 3 |
| | Central Dogma- DNA replication, transcription and translation | 4 | 3 | 1, 2, 3 |
| | Cell division – mitosis and meiosis | 2 | 3 | 1, 2, 3 |
| | Mutations, and genetic diseases. | 2 | 3 | 1, 2, 3 |

| | | | | |
|---|---|---|---|---|
| **Unit 4** | **Human Biology** | **11** | | |
| | Introduction to human body, cells and tissue organization | 1 | 4 | 1, 2, 3 |
| | Electrolytes and body fluids, Physiology of the blood | 1 | 4 | 1, 2, 3 |
| | Immune system | 1 | 4 | 1, 2, 3 |
| | Digestive system | 1 | 4 | 1, 2, 3 |
| | Respiratory system | 1 | 4 | 1, 2, 3 |
| | Endocrine system | 1 | 4 | 1, 2, 3 |
| | Nervous system | 1 | 4 | 1, 2, 3 |
| | Sensory systems -hearing, taste | 1 | 4 | 1, 2, 3 |
| | Sensory systems-smell, vision | 2 | 4 | 1, 2, 3 |
| | Reproduction | 1 | 4 | 1, 2, 3 |
| **Unit 5** | **Biological Sequences and Databases** | **5** | | |
| | Concept of genomics, transcriptomics, proteomics, and metabolomics | 1 | 5 | 4 |
| | File formats of sequence storage: FASTA file format | 1 | 5 | 4 |
| | Biological databases – NCBI, Usefulness of Biological metadata -array expression and 1000 genomes | 1 | 5 | 4 |
| | Applications of BLAST and protein/Gene ID conversion | 2 | 5 | 4 |
| **Total Contact Hours** | | **45** | | |

**Recommended Resources**


1. Thrives in Biochemistry and Molecular Biology, Edition 1, 2014, Cox, Harris, Pears, Oxford University Press.

2. Thrives in Cell Biology, Ed. 1, 2013, Qiuyu Wang, Chris Smith and Davis, Oxford University Press.

3. iGenetics: A Molecular Approach by Peter J Russell, 3rd edition, Pearson International Edition.

4. Bioinformatics Introduction – Mark Gerstein.


**Learning Assessment**

| **Bloom's Level of Cognitive Task** | | **Continuous Learning Assessments (50%)** | | | | **End Semester Exam (50%)** |
|---|---|---|---|---|---|---|
| | | **CLA-1 (10%)** | **Mid-1 (15%)** | **CLA-2 (10%)** | **CLA-3 (15%)** | |
| | | **Th** | **Th** | **Th** | **Th** | **Th** |
| | Remember | 100% | 100% | 100% | 80% | 80% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Level 1 | Understand | | | | | |
| Level 2 | Apply | | | | 20% | 20% |
| | Analyse | | | | | |
| Level 3 | Evaluate | | | | | |
| | Create | | | | | |
| **Total** | | **100%** | **100%** | **100%** | **100%** | **100%** |

**Course Designers**

All Faculty Members*, Department of Biological Sciences, SRM University – AP.*

# SRM University – AP, Andhra Pradesh
# Neerukonda, Mangalagiri Mandal
# Guntur District, Mangalagiri, Andhra Pradesh 522240

# Rust: The Programming Language

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | BIO | **Course Category** | Open Elective (OE) | **L-T-P-C** | 2 | 0 | 1 | 3 |
| **Pre-Requisite Course(s)** | | **Co-Requisite Course(s)** | | **Progressive Course(s)** | | | | |
| **Course Offering Department** | Biological Sciences | **Professional/Licensing Standard** | | | | | | |
| **Board of Studies Approval Date** | | **Academic Council Approval Date** | | | | | | |

## Course Objectives / Course Learning Rationales (CLRs)

Objective 1: Enable learners to apply Rust fundamentals to write clear, efficient, and safe code.

Objective 2: Develop problem5solving ability using ownership, error handling, and concurrency features unique to Rust.

Objective 3: Familiarize students with project organization, testing, debugging, and documentation practices.

Objective 4: Equip learners to extend Rust applications into domains like web development, graphics, GUIs, and scientific writing.

## Course Outcomes / Course Learning Outcomes (CLOs)

At the end of the course, the learner will be able to:

| | **At the end of the course the learner will be able to:** | **Bloom's Level** | **Expected Proficiency %** | **Expected Attainment %** |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| CO1 | Explain Rust’s advantages, limitations, and instal5 lation across operating systems; write simple pro5 grams. | 2 (Understand) | 90 | 80 |

| | | | | |
|---|---|---|---|---|
| CO2 | Apply Rust fundamentals (data types, functions, IO) to implement basic algorithms. | 3 (Apply) | 90 | 80 |
| CO3 | Organize Rust projects using modules, crates, and version control for maintainable software. | 3 (Apply/Analyze) | 85 | 75 |
| CO4 | Demonstrate ownership, borrowing, and mutability to implement safe and efficient algorithms. | 4 (Analyze) | 80 | 70 |
| CO5 | Employ error handling, testing, debugging, and con5 currency features in real5world programs. | 5 (Evaluate) | 75 | 65 |
| CO6 | Integrate external Rust libraries for web, graphics, GUI, and typesetting systems. | 6 (Create) | 70 | 60 |

## Course Articulation Matrix (CLOs → Program Learning Outcomes)

| **CLOs** | **Scientific and Disciplinary Knowledge** | **Analytical Reasoning and Problem Solving** | **Critical and Reflective Thinking** | **Scientific Reasoning and Design Thinking** | **Research Related Skills** | **Modern Tools and ICT Usage** | **Environment and Sustainability** | **Moral, Multicultural and Ethical Awareness** | **Individual and Teamwork Skills** | **Communication Skills** | **Leadership Readiness Skills** | **Self-Directed and Lifelong Learning** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | | 2 | 3 | 1 | 2 |
| CO2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | | 1 | | | 2 | 3 | 2 | 2 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | | 1 | | | 2 | 3 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | | 1 | | | 2 | 3 | 2 | 2 |
| CO5 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | | 1 | | | 2 | 3 | 3 | 3 |
| CO6 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | | 1 | | | 2 | 3 | 3 | 3 |
| Course Aver5 age | 3 | 2 | 3 | 3 | 2.5 | 1 | 3 | 0.5 | 1.3 | 0.5 | | 2 | 3 | 2.1 | 2.3 |

## Course Unitization Plan

| Unit | Topics | Contact Hours | CLOs Addressed | References |
|---|---|---|---|---|
| Unit I | Introduction: Rust Programming: Advantages and Limitations. Installing Rust (Windows/ Linux). First program: “Hello World”. | 5 | CO1 | 1,2 |
| Unit II | Fundamentals: Data Types, Variables, Deci5 sions, Iterations, Functions, IO operations. | 8 | CO2 | 1,2,3 |
| Unit III | Code Organization & Clarity: Binary vs Li5 brary, Public vs Private, Modules, Workspace setup, Crates, Version management. | 8 | CO3 | 1,2,4 |
| Unit IV | Programming Concepts: Ownership, Borrow5 ing, Mutability. Error Handling (Result, Op5 tion, panic). Documentation and code com5 ments. Testing & Debugging. Parallelism & Concurrency (threads, async/await, rayon). | 12 | CO4, CO5 | 3,4,5,6 |
| Unit V | Extending Boundaries with Libraries: Web development, GUI, Graphics (2D/3D visualiza5 tion), Typesetting systems. | 12 | CO6 | 5,6 |

| | |
|---|---|
| Total Contact Hours | 45 |

## Recommended Resources


1. Klabnik, S., & Nichols, C. (2023). **The Rust Programming Language**. 2nd ed. No Starch Press. ISBN: 9781718503106
2. Blandy, J., Orendorff, J., & Tindall, L. F. S. (2021). **Programming Rust**. 2nd ed. O'Reilly Media. ISBN: 9781492052548
3. McNamara, T. (2021). **Rust in Action**. Manning Publications. ISBN: 9781617294556
4. Gjengset, J. (2021). **Rust for Rustaceans: Idiomatic Programming for Experienced Developers**. No Starch Press. ISBN: 97851718501850
5. Rust Project Developers. **The Cargo Book**. Free online: https://doc.rust5lang.org/cargo/
6. Rust Project Developers. **The Rust Reference**. Free online: https://doc.rust5lang.org/reference/
7. Rust Project Developers. **Rust by Example**. Free online: https://doc.rust5lang.org/rust5by5example/


# Learning Assessment (Macro) - Theory

| Bloom's Level of Congnitive Task | | Continuous Learning Assessments (70%) | | | End Semester Assessments (30%) |
|---|---|---|---|---|---|
| | | CLA 5 I (15%) | CLA 5 II (20%) | CLA 5 III (35%) | |
| Level 1 | Remember | 100 | 60 | 10 | 30 |
| | Understand | | | | |
| Level 2 | Apply | | 40 | 20 | 30 |
| | Analyze | | | | |
| Level 3 | Evaluate | | | 70 | 40 |
| | Create | | | | |

| | | | |
|---|---|---|---|
| Total | 100% | 100% | 100% |

## Course Designer

- Dr. Naga Bhushana Rao Karampudi, Assistant professor, Department of Biological Sciences.