**ANNAMALAI UNIVERSITY**

**(Affiliated Colleges)**

**211 –B. Sc. Biotechnology**

**Programme Structure and Scheme of Examination (under CBCS)**

**(Applicable to the candidates admitted from the academic year 2023 -2024 onwards)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Part | Course Code | Study Components & Course Title | Credit | Hours/Week | Maximum Marks |
| CIA | ESE | Total |
|  |  | SEMESTER – I |  |  |  |  |  |
| I | 23UTAML11/23UHINL11/23UFREL11 | Language– I:பொது தமிழ் -I:தமிழிலக்கிய வரலாறு-IHindi-I/French-I | 3 | 6 | 25 | 75 | 100 |
| II | 23UENGL12 | General English - I | 3 | 6 | 25 | 75 | 100 |
| III | 23UBTHC13 | Core – I: Cell and Molecular Developmental Biology | 5 | 5 | 25 | 75 | 100 |
| 23UBTHP14 | Core – II: Practical – I: Cell and Molecular Developmental Biology Practical  | 5 | 4 | 25 | 75 | 100 |
| 23UMICE15 | Elective – I Fundamentals of Microbiology | 2 | 3 | 25 | 75 | 100 |
|  | 23UMICEP1 | Fundamentals of Microbiology Practical | 1 | 2 | 25 | 75 | 100 |
| IV | 23UTAMB1623UTAMA16 | Skill Enhancement Course – I\*NME-I /Basic Tamil – I /Advanced Tamil - I | 2 | 2 | 25 | 75 | 100 |
| 23UBTHF17 | Foundation Course:Microbial Diseases and Control | 2 | 2 | 25 | 75 | 100 |
|  |  | Total | 23 | 30 |  |  | 800 |
|  |  | SEMESTER – II |  |  |  |  |  |
| I | 23UTAML2123UHINL21/23UFREL21 | Language– II:பொது தமிழ் -II: தமிழிலக்கிய வரலாறு-2/Hindi-IIFrench-II | 3 | 6 | 25 | 75 | 100 |
| II | 23UENCL22 | General English – II | 3 | 6 | 25 | 75 | 100 |
| III | 23UBTHC23 | Core – III: Genetics | 5 | 5 | 25 | 75 | 100 |
| 23UBTHP24 | Core – IV: Practical – II: Lab in Genetics  | 5 | 4 | 25 | 75 | 100 |
| 23UMICE25 | Elective – I:Applied Microbiology | 2 | 3 | 25 | 75 | 100 |
|  | 23UMICEP2 | Applied Microbiology Practical | 1 | 2 | 25 | 75 | 100 |
| IV | 23UTAMB2623UTAMA26 | Skill Enhancement Course – II\*NME-II /Basic Tamil – II /Advanced Tamil - II | 2 | 2 | 25 | 75 | 100 |
| 23USECG27 | Skill Enhancement Course – IIIInternet and its Applications(Common Paper) | 2 | 2 | 25 | 75 | 100 |
| 23UNMSD01 | Language Proficiency for employability: Overview of English Communication\*\* | 2 | - | 25 | 75 | 100 |
|  |  | Total | 25 | 30 |  |  | 900 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | SEMESTER – III |  |  |  |  |  |
| I | 23UTAML31/23UHINL31/23UFREL31 | Language – III பொது தமிழ் -III: தமிழக வரலாறும், பண்பாடும்/Hindi-III/French-III | 3 | 6 | 25 | 75 | 100 |
| II | 23UENGL32 | General English - III | 3 | 6 | 25 | 75 | 100 |
| III | 23UBTHC33 | Core - V - Immunology and Immunotechnology | 5 | 5 | 25 | 75 | 100 |
| 23UBTHP34 | Core - VI – Practical III: Lab in Immunology and Immunotechnology | 5 | 5 | 25 | 75 | 100 |
| 23UBTHE35 | Elective III :Bioinstrumentation | 3 | 4 | 25 | 75 | 100 |
| IV | 23UBTHS36 | Skill Enhancement Course - IV:Bioinstrumentation (Practical) | 1 | 1 | 25 | 75 | 100 |
| 23UBTHS37 | Skill Enhancement Course – V:Herbal Biotechnology | 2 | 2 | 25 | 75 | 100 |
|  | Environmental Studies | - | 1 | - | - | - |
|  |  | Total | 22 | 30 |  |  | 700 |
|  |  | SEMESTER – IV |  |  |  |  |  |
| I | 23UTAML4123UHINL41/23UFREL41 | Language – IV:பொது தமிழ் -IV: தமிழும் அறிவியலும்/Hindi-IV/French-IV | 3 | 6 | 25 | 75 | 100 |
| II | 23UENGL42 | General English – IV | 3 | 6 | 25 | 75 | 100 |
| III | 23UBTHC43 | Core - VII – Genetic Engineering and rDNA Technology | 5 | 5 | 25 | 75 | 100 |
| 23UBTHP44 | Core -VIII – Practical IV: Lab in Genetic Engineering and rDNA Technology | 5 | 5 | 25 | 75 | 100 |
| 23UBTHE45 | Elective IV :Bioinformatics and Biostatistics  | 3 | 3 | 25 | 75 | 100 |
| IV | 23UBTHS46 | Skill Enhancement Course – VI: Practical - Bioinformatics and Biostatistics | 2 | 2 | 25 | 75 | 100 |
| 23UBTHS47 | Skill Enhancement Course – VII:Vermiculture | 2 | 2 | 25 | 75 | 100 |
| 23UEVSG48 | Environmental Studies | 2 | 1 | 25 | 75 | 100 |
|  |  | Total | 25 | 30 |  |  | 800 |
|  |  | SEMESTER – V |  |  |  |  |  |
| I | 23UBTHC51 | Core IX – Plant Biotechnology | 4 | 5 | 25 | 75 | 100 |
| II | 23UBTHC52 | Core X- Animal Biotechnology | 4 | 5 | 25 | 75 | 100 |
| III | 23UBTHC53 | Core XI - Environmental and Industrial Biotechnology | 4 | 5 | 25 | 75 | 100 |
| 23UBTHD54 | Core – XII Project with viva-voce | 4 | 5 | 25 | 75 | 100 |
| 23UBTHE55 | Elective V:Practical V– Plant Biotechnology and Animal Biotechnology (Practical) | 3 | 4 | 25 | 75 | 100 |
|  | 23UBTHE56 | Elective VI: Practical VI- Environmental And Industrial Biotechnology (Practical) | 3 | 4 | 25 | 75 | 100 |
| IV | 23UVALG57 | Value Education | 2 | 2 | 25 | 75 | 100 |
| 23UBTHI58 | Summer Internship**++** | 2 | – | 25 | 75 | 100 |
|  |  | Total | 26 | 30 |  |  | 800 |

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| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | SEMESTER – VI |  |  |  |  |  |
| I | 23UBTHC61 | Core – XIII - Food Technology | 4 | 6 | 25 | 75 | 100 |
| II | 23UBTHC62 | Core – XIV- Pharmaceutical Biotechnology | 4 | 6 | 25 | 75 | 100 |
| III | 23UBTHC63 | Core – XV- Aquaculture Biotechnology | 4 | 6 | 25 | 75 | 100 |
| 23UBTHE64-123UBTHE64-223UBTHE64-3 | Elective VII:Environment Management in Industries /Marine Biotechnology /Bio-entrepreneurship  | 3 | 5 | 25 | 75 | 100 |
| 23UBTHE65-123UBTHE65-223UBTHE65-3 | Elective VIII:Forensic Biotechnology /Good Laboratory Practices /Bioprospecting | 3 | 5 | 25 | 75 | 100 |
| IV | 23UBTHF66 | Professional Competency Skill: Molecular Diagnostics | 2 | 2 | 25 | 75 | 100 |
| V | 23UBTHX67 | Extension Activity | 1 | – | 25 | 75 | 100 |
|  |  | Total | 21 | 30 |  |  | 700 |
|  |  | Grand Total | 142 |  |  |  | 4700 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Non-major (NME) Electives offered to other Departments |  |  |  |
| IV | 23UBTHN16 | Mushroom Technology | 2 | 2 | 25 | 75 | 100 |
| 23UBTHN26 | Environmental Management | 2 | 2 | 25 | 75 | 100 |

\* PART-IV: NME / Basic Tamil / Advanced Tamil (Any one)

Students who have not studied Tamil upto 12th Standardand have taken any Language other than Tamil in Part-I, must choose Basic Tamil-I in First Semester & Basic Tamil-II in Second Semester.

Students who have studied Tamil upto 10th & 12th Standardand have taken any Language other than Tamil in Part-I, must choose Advanced Tamil-I in First Semester and Advanced Tamil-II in Second Semester.

\*\* The course “23UNMSD01: Overview of English Communication” is to be taught by the experts from
 Naan Mudhalvan Scheme team. However, the faculty members of Department of English should
 coordinate with the Naan Mudhalvan Scheme team for smooth conduct of this course.

++Students should complete two weeks of internship before the commencement of V semester.

**++**Students should complete two weeks of internship before the commencement of V semester.

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credit and Hours Distribution System**

**for all UG courses including Lab Hours**

**First Year – Semester-I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part I | Language – Tamil  | 3 | 6 |
| Part II | English | 3 | 6 |
| Part III | Core Theory, Practical & Elective Courses  | 13 | 14 |
| Part IV | Skill Enhancement Course SEC-1 (NME-I) | 2 | 2 |
| Foundation Course | 2 | 2 |
|  |  | **23** | **30** |

**Semester-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part I | Language – Tamil | 3 | 6 |
| Part II |  English | 3 | 6 |
| Part III | Core Theory, Practical & Elective Courses  | 13 | 14 |
| Part IV | Skill Enhancement Course -SEC-2 (NME-II) | 2 | 2 |
| Skill Enhancement Course -SEC-3 (Discipline / Subject Specific) | 2 | 2 |
|  |  | **23** | **30** |

**Second Year – Semester-III**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part I | Language - Tamil | 3 | 6 |
| Part II |  English | 3 | 6 |
| Part III | Core Theory, Practical & Elective Courses | 13 | 14 |
| Part IV | Skill Enhancement Course -SEC-4 (Entrepreneurial Based) | 1 | 1 |
| Skill Enhancement Course -SEC-5 (Discipline / Subject Specific) | 2 | 2 |
|  E.V.S  | - | 1 |
|  |  | **22** | **30** |

**Semester-IV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part I | Language - Tamil | 3 | 6 |
| Part II |  English | 3 | 6 |
| Part III | Core Theory, Practical & Elective Courses | 13 | 13 |
| Part IV | Skill Enhancement Course -SEC-6 (Discipline / Subject Specific) | 2 | 2 |
| Skill Enhancement Course -SEC-7 (Discipline / Subject Specific) | 2 | 2 |
|  E.V.S  | 2 | 1 |
|  |  | **25** | **30** |

**Third Year**

**Semester-V**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part III | Core Theory, Practical, Project & Elective Courses | 22 | 28 |
| Part IV | Value Education  | 2 | 2 |
| Internship / Industrial Visit / Field Visit | 2 | - |
|  |  | **26** | **30** |

**Semester-VI**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part III | Core Theory, Practical & Elective Courses | 18 | 28 |
| Part IV | Professional Competency Skill | 2 | 2 |
| Part V | Extension Activity | 1 | - |
|  |  | **21** | **30** |

**Consolidated Semester wise and Component wise Credit distribution**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parts**  | **Sem I** | **Sem II** | **Sem III** | **Sem IV** | **Sem V** | **Sem VI** | **Total Credits** |
| **Part I** | 3 | 3 | 3 | 3 | - | - | 12 |
| **Part II** | 3 | 3 | 3 | 3 | - | - | 12 |
| **Part III** | 13 | 13 | 13 | 13 | 22 | 18 | 92 |
| **Part IV**  | 4 | 4 | 3 | 6 | 4 | 2 | 23 |
| **Part V** | - | - | - | - | - | 1 | 1 |
| **Total** | 23 | 23 | 22 | 25 | 26 | 21 | **140** |

**\*Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components Part IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

**CREDIT DISTRIBUTION FOR U.G. PROGRAMME**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Part** | **Course Details** | **No. of Courses** | **Credit per course** | **Total****Credits** |
| **Part I** | Tamil | 4 | 3 | 12 |
| **Part II** | English | 4 | 3 | 12 |
| **Part III** | Core Courses  | 15 | 4/5 | 68 |
| Elective Courses: Generic / Discipline Specific (3 or 2+1 Credits) | 8 | 3 | 24 |
| **Part I, II and III Credits**  | 116 |
| **Part IV** | Skill Enhancement Courses / NME / Language Courses | 7 | 1/2 | 15 |
| Professional Competency Skill Course | 1 | 2 | 2 |
| Environmental Science (EVS) | 1 | 2 | 2 |
| Value Education  | 1 | 2 | 2 |
| Internship | 1 | 2 | 2 |
| **Part IV Credits** | **23** |
| **Part V** | Extension Activity (NSS / NCC / Physical Education) | 1 | 1 | 1 |
| **Total Credits for the UG Programme**  | **140** |

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| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze(K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate(K5)** | Longer essay/Evaluation essay, Critique or justify with pros and cons |
| **Create(K6)** | Check knowledge in specific or off beat situations, Discussion, Debating or Presentations |

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| **Programme Outcomes:** | **PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study**PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one’s views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.**PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one’s learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.**PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation**PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team**PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.**PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. **PO10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.**PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability toembrace moral/ethical values in conducting one’s life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstratingthe ability to identify ethical issues related to one‟s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.**PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.**PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling. |
| **Programme Specific Outcomes:** | On successful completion of Bachelor of Physics with Computer Applications programme, the student should be able to:**PSO1: Disciplinary Knowledge:** Understand the fundamental principles, concepts, and theories related to physics and computer science. Also, exhibit proficiency in performing experiments in the laboratory.**PSO2: Critical Thinking:** Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively**PSO3: Problem Solving:** Employ theoretical concepts and critical reasoning ability with physical, mathematical and technical skills to solve problems, acquire data, analyze their physical significance and explore new design possibilities.**PSO4: Analytical & Scientific Reasoning:** Apply scientific methods, collect and analyse data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models.**PSO5: Research related skills:** Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects.**PSO6: Self-directed & Lifelong Learning:** Set learning goals, manage their own learning, reflect on their learning, adapt to new contexts, seek out new knowledge, collaborate with others and to continuously improve their skills and knowledge, through ongoing learning and professional development, and contribute to the growth and development of their field.  |

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| --- | --- | --- | --- | --- | --- | --- |
| **PO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** |
| **PO1** |  |  |  |  |  |  |
| **PO2** |  |  |  |  |  |  |
| **PO3** |  |  |  |  |  |  |
| **PO4** |  |  |  |  |  |  |
| **PO5** |  |  |  |  |  |  |
| **PO6** |  |  |  |  |  |  |

**FIRST YEAR - SEMESTER – I**

|  |  |  |
| --- | --- | --- |
| **SEMESTER: I****CORE-I****PART: III** | **23UBTHC13:****CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY** | **CREDIT: 5****HOURS: 5/W** |

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| **Learning Objective: On successful completion of the course, students will be able to** |
| LO1 | Have an insight of the cell as the fundamental unit of life and to compare the structure of the Eukaryotic cell with the primitive prokaryotic cell  |
| LO2 | Analyze the structure and obtain a strong foundation about the functional aspects of cell organelles and cell membrane. |
| LO3 | Study the structure and functions of Nucleic acid and discuss the molecular mechanism of Replication, Transcription and Translation and post translational modifications of proteins. |
| LO4 | Predict the response of cells to the intra and extracellular environment by studying about the intracellular signaling pathways. |
| LO5 | Understand the principles and molecular mechanisms involved in cellular differentiation, morphogenesis, growth and Potency of the cell. |
| **UNIT** | **Contents** | **No. of Hours** |
| I | Discovery and diversity of cells - Cell theory - Structure of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells). | 10 |
| II | Biomacromolecules and Biomicromolecules (Primary functions in the cell). Structure and Functions of Cell Organelles: Cell wall - Cell membrane - Cytoplasm - Nucleus - chromosomes -Endoplasmic reticulum - Ribosomes - Golgi bodies - Plastids - Vacuoles - Lysosomes - Mitochondria - Microbodies - Flagella - Cilia - Centrosome and Centrioles - Cytoskeleton. | 20 |
| III | Structure and functions of DNA and RNA -Central Dogma of the cell. DNA -Replication in prokaryotes - Transcription in Prokaryotes and Eukaryotes - RNA Processing - Genetic code- Translation - Similarities and differences in prokaryotic and eukaryotic translation - Post Translational Modifications - Protein Sorting - Protein degradation. | 15 |
| IV | Cell cycle - Cell cycle checkpoints - Cell division - Mitosis and Meiosis - Cellular differentiation - Cell junctions - Cell Adhesion - ExtraCellular Matrix - Cell to cell communications - Signal transduction - G - Protein Coupled Receptors Signal transduction pathways. | 15 |
| V | Gametogenesis - Spermatogenesis and Oogenesis in mammals. Fertilization- Types of cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals- Organogenesis. | 15 |
| **Total** | **75** |

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| **Text Books** |
| 1 | T. Devasena (2012), Cell Biology, Oxford University Press. |
| 2 | Gupta, Renu&Makhija, Seema&Toteja, Ravi. (2018). Cell Biology: Practical Manual. |
| 3 | Gilbert, S.F. 2016. Developmental Biology, 11th edition. Sinauer Associates Inc. Publishers, MA. USA. |
| 4 | Bruce Alberts, 6th Edition (2014). Molecular Biology of the cell, W. W. Norton & Company.  |
| 5 | James D. Watson (2001), The Double Helix: A personal account of the Discovery of the Structure of DNA, Touchstone Publishers. |
| **Reference Books** |
| 1 | Karp’s Cell and Molecular Biology: Concepts and Experiments. 8th Edition (2015). Wiley Publications.  |
| 2 | James D. Watson, 7th Edition (2014), Molecular Biology of the Gene, Pearson Publications.  |
| 3 | Geoffrey M. Cooper, 7th Edition (2015). The Cell: A Molecular Approach, Sinauer Associates, Qxford University Press. |
| 4 | LodishHarwey, 6th Edition (2016), Molecular Cell Biology, W. H. Freeman Publications. |
| 5 | Wolpert L, Tickle C, 2015. Principles of Development, 5th edition, Oxford University Press. |
| **Web Resources** |
| 1 | <http://www.cellbiol.com/education.php> |
| 2 | <https://global.oup.com/uk/orc/biosciences/cellbiology/wang/student/weblinks/ch16/> |
| 3 | <https://dnalc.cshl.edu/websites/> |
| 4 | <https://www.cellsignal.com/contents/science/cst-pathways/science-pathways> |
| 5 | <https://nptel.ac.in/courses/102/106/102106025/>11. |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PSO1** | **PSO2** | **PSO3** |
| **CLO1** | 3 | 2 | 1 | 3 | - | 3 | 3 | 2 | 3 |
| **CLO2** | 3 | 3 | 3 | 3 | - | 3 | 3 | 2 | 3 |
| **CLO3** | 3 | 3 | 3 | 2 | - | 3 | 3 | 2 | 2 |
| **CLO4** | 3 | 2 | 3 | 2 | - | 3 | 3 | 2 | 3 |
| **CLO5** | 3 | 3 | 2 | 2 | - | 3 | 3 | 2 | 3 |
| **TOTAL** | **15** | **14** | **12** | **12** | **0** | **15** | **15** | **10** | **15** |
| **AVERAGE** | **3** | **2.8** | **2.4** | **2.4** | **0** | **3** | **3** | **2** | **3** |

|  |  |  |
| --- | --- | --- |
| **SEMESTER: I****CORE PRACTICAL: I****PART: III** | **23UBTHP14: CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY PRACTICAL** | **CREDIT: 5****HOURS: 4/W** |

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| **Learning Objective** |
| LO1 | Demonstrate the operation of Light Microscope |
| LO2 | Identify blood cells and its components |
| LO3 | Isolate and identify plant, and animal cells. |
| LO4 | Summarizes the concept of gametes |
| LO5 |  Develop skill to perform cell fractionations. |
| **UNIT** | **Contents** | **No.of Hours** |
| I | Components of a Compound / Light Microscope. | 9 |
| II | Blood smear preparation and Identification of Blood cells Buccal smear preparation and Identification of squamous epithelial cells. | 9 |
| III | Isolation and Identification of plant cells. | 9 |
| IV | Observation of sperm & EggMounting of chick Embryo - 24 hrs, 48 hrs, 72 hrs, 96 hrs.Types of placenta in mammals. | 9 |
| V | Cell fractionation and Identification of cell organelles (Demo) | 9 |
| **Total** | **45** |
| **Text Books** |
| 1 | K.V. Chaitanya, (2013), *Cell and molecular biology*: Lab manual, PHI publishers,. ISBN 978-81-203-800-4 |

**MAPPING WITH PROGRAMME OUTCOMESAND PROGRAMME SPECIFIC OUTCOME**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PSO1** | **PSO2** | **PSO3** |
| **CLO1** | 3 | 3 | 3 | 3  | 2  | 3  |  3 | 2 |  2 |
| **CLO2** | 3 | 3 | 3 |  3 |  3 |  3 |  3 |  2 |  2 |
| **CLO3** | 3 | 3 | 3 |  3 |  3 |  3 |  3 |  3 |  3 |
| **CLO4** | 3 | 2 | 3 |  3 |  3 |  3 |  3 |  3 |  3 |
| **CLO5** | 3 | 3 | 2 |  3 |  2 |  2 | 2  |  3 | 3 |
| **TOTAL** | **15** | **14** | **14** | **15** | **13** | **14** | **14** | **13** | **13** |
| **AVERAGE** | **3** | **2.8** | **2.8** | **3** | **2,6** | **2.8** | **2.8** | **2.6** | **2.6** |

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| **SEMESTER: I****ElectivePART: III** | **Elective – I: 23UMICE15:****Fundamentals of Microbiology** | **CREDIT: 2****HOURS: 3/W** |

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| **Learning Objective** |
| LO1 | Understand the classification of Microorganisms and structure of bacteria |
| LO2 | Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms. |
| LO3 | Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes. |
| LO4 |  Exhibit knowledge in analyzing the importance of Bio insecticides, Bio fertilizers prebiotics and probiotics. |
| LO5 | Distinguish between normal flora and pathogens and describe the role of microbes in food intoxications. |
| **UNIT** | **Contents** | **No.of Hours** |
| I | History of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope of microbiology – Role of microbes in biotechnology. |  15 |
| II | Structure of bacteria - Bacterial growth and measurement of growth, Media – types and preparation- plating methods - staining methods (Gram’s, capsule, spore, LCB mount)- methods of preservation and storage of microbes. Culture of fungi, virus and algae. | 15 |
| III | Sterilization methods - physical and chemical methods- Mode of action – Antibiotic in clinical use - Resistance to antibacterial agents - MRSA, ESBL. | 15 |
| IV | Bioinsecticides - *Bacillus thuringiensis*, Baculoviruses- Biofertilizers -*Azospirillum* and blue green algae - single cell protein – prebiotics and probiotics - Dairy products (Cheese and Yoghurt). | 15 |
| V | Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector borne disease (Dengue, Malaria). | 15 |
| **Total** | **75** |
| **Text Books** |
| 1 | Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition.,McGraw –Hill, New York. |
| 2 | Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co. |
| 3 | Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013. |
| 4 | Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016. |
| 5 | Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC |
| **Reference Books** |
| 1 | Madigan, Martinko, Bender, Buckley, Stahl, Brock Biology of Microorganisms, 14th edition, 2017. |
| 2 | Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4th edition, 2012. |
| 3 | Boyd, R.F. (1998). General Microbiology,2ndEdition., Times Mirror, Mosby CollegePublishing, St Louis. |
| 4 | Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11thEdition., A La Carte Pearson. |
| 5 | Salle. A.J (1992). Fundamental Principles of Bacteriology. 7th Edition., McGraw Hill Inc.New York. |

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| **Web Resources** |
| 1 | Horst W. Doelle (2004). Microbial Metabolism and Biotechnology. Proceedings of an E-seminar organized by the International organization for Biotechnology and Bioengineering (IOBB) |
| 2 | <http://www> ejb.org/content. |
| 3 | www. Biotech.kth.se Electronic Journal of biotechnology |
| 4 | https://www.cliffsnotes.com/study guides/biology/microbiology/introduction-to- microbiology/a-brief-history-of-microbiology |
| 5 | [https://bio.libretexts.org/@go/page/9188](https://bio.libretexts.org/%40go/page/9188) |

**MAPPING WITH PROGRAMME OUTCOMESAND PROGRAMME SPECIFIC OUTCOME**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PSO1** | **PSO2** | **PSO3** |
| **CLO1** | **3** | **3** | **3** |  **3** |  **3** |  **3** |  **3** |  **3** |  **3** |
| **CLO2** | **3** | **3** | **3** |  **3** |  **3** |  **3** |  **3** |  **3** |  **3** |
| **CLO3** | **3** | **3** | **3** |  **3** |  **2** |  **3** |  **3** |  **3** |  **3** |
| **CLO4** | **3** | **3** | **3** |  **2** |  **3** |  **2** |  **3** |  **3** |  **2** |
| **CLO5** | **3** | **3** | **2** |  **3** |  **3** |  **3** |  **3** |  **2** |  **3** |
| **TOTAL** | **15** | **15** | **14** | **14** | **14** | **14** | **15** | **14** | **14** |
| **AVERAGE** | **3** | **3** | **2.8** | **2.8** | **2.8** | **2.8** | **3** | **2.8** | **2.8** |

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| **SEMESTER: I****ELECTIVE II:****PART: III** | **23UMICEP1: FUNDAMENTALS OF MICROBIOLOGY Practical** | **CREDIT: 1****HOURS: 2/W** |

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| **Learning Objective** |
| LO1 | Describe the general Laboratory safety & Sterilization Techniques  |
| LO2 | Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques  |
| LO3 | Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques. |
| LO4 | Perform the Motility of organisms. |
| LO5 | Able to characterize and identify bacteria using Biochemical tests.  |
| **UNIT** | **Contents** | **No.of Hours** |
| I | Sterilization techniques – Preparation of Media | 9 |
| II | Inoculation techniques- Pour plate, spread plateIsolation of bacteria from various sources and dilution techniques. | 9 |
| III | Staining techniques: Simple, Gram’s, Capsule (Negative), Spores,Preparation of temporary mounts- Lacto phenol cotton blue staining. | 9 |
| IV | Motility tests: Hanging drop technique.  | 9 |
| V | Biochemical characterization - catalase, oxidase, IMVIC test and TSI.Antibiotic sensitivity test (demonstration). | 9 |
| **Total** | **45** |
| **Text Books** |
| 1 | James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996. |
| 2 | Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications. |
| 3 | Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications. |
| 4 | Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi. |
| 5 |  R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing. |
| **Reference Books** |
| 1 | Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers. |
| 2 | Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India. |
| 3 | Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS. |
| 4 | Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication. |
| 5 | Lim D. (1998). Microbiology, 2nd Edition, WCB McGraw Hill Publications. |
| **Web Resources** |
| 1 | <http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403>. |
| 2 | <https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635> |
| 3 | [https://www.grsmu.by/files/file/university/cafedry//files/essential\_microbiology.pdf](https://www.grsmu.by/files/file/university/cafedry/files/essential_microbiology.pdf) |
| 4 | <https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology> |

**MAPPING WITH PROGRAMME OUTCOMESAND PROGRAMME SPECIFIC OUTCOME**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PSO1** | **PSO2** | **PSO3** |
| **CLO1** | **3** | **2** | **2** |  **2** |  **1** |  **2** |  **3** |  **3** |  **3** |
| **CLO2** | **3** | **2** | **2** |  **2** |  **1** |  **1** |  **3** |  **3** |  **3** |
| **CLO3** | **3** | **2** | **1** |  **1** |  **-** |  **1** |  **3** |  **3** |  **3** |
| **CLO4** | **3** | **2** | **1** |  **2** |  **3** |  **2** |  **3** |  **3** |  **2** |
| **CLO5** | **3** | **3** | **2** |  **3** |  **3** |  **2** |  **3** |  **2** |  **3** |
| **TOTAL** | **15** | **11** | **8** | **10** | **8** | **8** | **15** | **14** | **14** |
| **AVERAGE** | **3** | **2.2** | **1.6** | **2** | **1.6** | **1.6** | **3** | **2.8** | **2.8** |

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| **SEMESTER: I****Foundation Course:****PART: IV** | **23UBTHF17: Microbial Diseases and Control****(Foundation Course)** | **CREDIT: 2****HOURS: 2/W** |

**Learning Outcome:**

The paper imparts a thorough knowledge on the basics of concepts of microbial interactions and clinical manifestation and its control.

**Course outcomes**:

At the end of the Course, the Student will be able to:

|  |  |
| --- | --- |
| CO-1 | Understand the microbial interactions and its prevention and control. |
| CO-2 | Knowledge about the Virus and clinical manifestation |
| CO-3 | Knowledge about the bacteria and clinical manifestation |
| CO-4 | Knowledge about the fungi and clinical manifestation |
| CO-5 | Knowledge about the Protozoa and clinical manifestation |

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| **SYLLABUS | Paper - 1 | MICROBIAL DISEASES AND CONTROL** |
| **Unit** | **Content** | **Hours** | **COs** | **Cognitive level** |
| **I** | Micro organisms - microbial interactions - pathogens.General epidemiology - pathogenesis - pathology - diagnostic procedure - clinical manifestation - prevention and control measures. | 6 | CO1 | K1&k2 |
| **II** | Virus: (a) HIV, (b) Pox virus, and (c) Picorna virus - Epidemiology - pathogenesis - pathology – diagnostics procedure - clinical manifestation - prevention and control measures. | 7 | CO2 | K1,K2 & K3 |
| **III** | Bacteria: (a) Streptococcus (b) Staphylococcus and (c) Salmonella - Epidemiology - pathogenesis - pathology - diagnostic procedure - clinical manifestation - prevention and control measures | 7 | CO3 | K1,K2 & K3 |
| **IV** | Fungi: (a) Aspergillus, (b) Candida and (c) Microspora - Epidemiology - pathogenesis - pathology - diagnostic procedure - clinical manifestation - prevention and control measures. | 7 | CO4 | K1,K2 & K3 |
| **V** | Protozoa: (a) Entamoeba histolytica, (b) Plasmodium species and (c) Trypanosoma gambiense - Epidemiology - pathogenesis - pathology - diagnostic procedure - clinical manifestation - prevention and control measures - vectors. | 7 | CO5 | K1,K2 & K3 |
| **Reference books:**1. Ananthanarayanan, R. and C.K., Jayaram Paniker, Textbook of Microbiology. Orient Longman, 5th Edition, (1994).
2. Jawetz, E., Melnic, J.L. and Adelberg E. A., Review of Medical Microbiology. Lange Medical publications, USA, 4th Edition, (1998).
3. Mackie and Mc Cartney, Medical Microbiology No 1 and II. Churchill Livingston, 14th Edition, (1994).
4. Chakraborty, P. A text book of microbiology, New central Book agency pvt Ltd. Calcutta, 2nd Edition, (1995).
5. Bailey and Scotts, Diagnostic Microbiology, Baron and Finegold CV Mosby publications, 9th Edition, (1994).
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| **SEMESTER: I****Core-III:****PART: III** | **Core – III:****23UBTHC23: Genetics** | **CREDIT: 5****HOURS: 5/W** |

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| **Learning Objective** |
| LO1 |  Learn about the classical genetics and transmission of characters from one generation to the next. |
| LO2 | Obtain a strong foundation for the advanced genetics. |
| LO3 |  Explain the properties of genetic materials and storage and processing of genetic information. |
| LO4 |  Acquire knowledge about the Mutagens, Mutations, DNA Repairs and Genetic disorders in human. |
| LO5 |  Categories Eugenics, Euphenics and Euthenicsand indepth Knowledge on population Genetics. |
| **UNIT** | **Contents** | **No.of Hours** |
| 1 | Mendel’s experiments, Monohybrid cross, Dihybrid cross, Backcross or Testcross, Mendel’s laws. Incomplete dominance. Interaction of Genes- Epistasis -lethal genes. Multiple alleles – In Drosophila, Rabbit and Blood group inheritance in man. |  15 |
| II | Linkage - linkage in Drosophila- Morgan’s experiments, factors affecting linkage. Crossing over- types, mechanism, significance of crossing over. Mapping of Chromosomes, interference and coincidence. Cytoplasmic inheritance -Carbon dioxide sensitivity in Drosophila and milk factor inmice. Sex –Linked Inheritance and Sex- Determination in Man. | 15 |
| III |  Fine structure of the gene and gene concept, Operon Concept. Identification of the DNA as the genetic material- Griffith experiments, Avery, McLeod, McCarty and Hershey Chase experiment. Microbial Genetics- bacterial recombination, Conjugation, Transformation, Transduction and sexduction | 15 |
| IV | Mutation – types of mutation, mutagens, DNA damage and Repair Mechanism. Chromosomal aberrations- Numerical and Structural, Pedigree Analysis-Mendelian inheritance in human. (Cystic Fibrosis, Muscular Dystrophy) | 15 |
| V | Population Genetics– Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency. Eugenics, Euphenics and Euthenics. | 15 |
| **Total** | 75 |
| **Text Books** |
| 1 | Dr. Veer BalaRastogi, 2020, Elements of Genetics, 11 th Revised & Enlarged Edition, KedarNath Ram |
| 2 | NathPublications,Meerut,250001.www.knrnpublications.com, ISBN-978-81-907011-2-9 |
| 3 | Verma, P.S. and Agarwal, V.K., 1995. Genetics, 8th edition, S.Chand& Co., New Delhi – 10055. |
| 4 | Verma, P.S., and Agarwal, V.K., 1995. Cell and Molecular Biology, 8th edition, S.Chand and Co., New Delhi, 110055. |
| **Reference Books** |
| 1 | Gardener E.J. Simmons M.J. Slustad D. P. 2006. Principles of Genetics |
| 2 | Lewis, R.2001. Human Genetics- Concepts and application. 4th edition. McGraw Hill. |
| 3 | Griffiths, Miller, J.H., An Introduction to Genetic Analysis W.H.Freeman. New York. |
| 4 | Winter, P.C., Hickey, G.J. and Fletcher, H.L.2000. Instant notes in Genetics. Viva books, Ltd |
| 5 | Good enough U. 1985. Genetics. Hold Saunders international. |
| **Web Resources** |
| 1 | <https://nptel.ac.in/courses/102/106/102106025/> |
| 2 | [http://www.ocw.mit.edu](http://www.ocw.mit.edu/) |
| 3 | [http://enjoy.m.wikipedia.org](http://enjoy.m.wikipedia.org/) |
| 4 | [https://www.acpsd.net](https://www.acpsd.net/) |

**MAPPING WITH PROGRAMME OUTCOMEAND PROGRAMME SPECIFIC OUTCOME**

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|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PSO1** | **PSO2** | **PSO3** |
| **CLO1** | **3** | **3** | **3** | **3**  | **2**  | **3**  |  **3** | **2** |  **2** |
| **CLO2** | **3** | **3** | **3** |  **3** |  **3** |  **3** |  **3** |  **2** |  **2** |
| **CLO3** | **3** | **3** | **3** |  **3** |  **3** |  **3** |  **3** |  **3** |  **3** |
| **CLO4** | **3** | **2** | **3** |  **3** |  **3** |  **3** |  **3** |  **3** |  **3** |
| **CLO5** | **3** | **3** | **2** |  **3** |  **2** |  **2** | **2**  |  **3** | **3** |
| **TOTAL** | **15** | **14** | **14** | **15** | **13** | **14** | **14** | **13** | **13** |
| **AVERAGE** | **3** | **2.8** | **2.8** | **3** | **2.6** | **2.8** | **2,8** | **2.6** | **2.6** |

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| **SEMESTER: I****CORE PRACTICAL:****PART: III** | **Core – IV: Practical – II:****23UBTHP24: Lab in Genetics**  | **CREDIT: 5****HOURS: 4/W** |

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| **SYLLABUS | Core -4- Practical | GENETICS** |
| **Content** |
| 1 .Mitotic stages of onion (*Allium cepa*) root tip 2. Meiotic stages of cockroach testes/ Flower bud3.Giant chromosomes from Chironomus larvae4. Giant chromosomes from Drosophila salivary glands5. Identification of Barr bodies from Buccal smear6.Preparations of culture medium and culture of Drosophila – methods of maintenance 7. Identifications of mutants of Drosophila8. Human karyotyping (Demo) |

**Elective II: APPLIED MICROBIOLOGY**

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| **Subject Code** | **L** | **T** | **P** | **S** | **Credits** | **Instructional Hours** | **Marks** |
| **CIA** | **External** | **Total** |
| **23UMICE25** | **3** |  |  |  | **2** | **3** | **25** | **75** | **100** |
| **Course Outcomes** |
| CO1 | Understand beneficial role of microorganisms in dairy and food products. |
| CO2 | Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms. |
| CO3 | Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes. |
| CO4 |  Exhibit knowledge in analyzing the importance of Bio insecticides, Bio fertilizers prebiotics and probiotics. |
| CO5 | Distinguish between normal flora and pathogens and describe the role of microbes in food intoxications. |
| **UNIT** | **Contents** | **No. of Hours** |
| I | Microorganisms as food and feed: SCP, Mushroom-Oyster (Pleurotus) and Button (Agaricus) mushroom. Dairy products-cheese, yoghurt; Beverages-Beer and Wine. Probiotics. |  15 |
| II | Microorganisms in Agriculture: Bacterial Biofertilizers, Phosphate solubilizers, Vasicular Arbusucular Mycorrhizae, Algal Biofertilizers. | 15 |
| III | Biocontrol of microbial pathogens-Bio pesticide-Bactericide-*Bacillus thuringiensis*; Fungicide-*Trichoderma viridae-*Viral Biopesticides-CPV and NPV | 15 |
| IV | Microorganisms and Environment: liquid waste and solid waste-liquid waste management-water recycling- Industrial effluent treatment (sugar mill effluent, tannery effluent)- Solid waste management -Composting and vermicomposting. | 15 |
| V | Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector borne disease (Dengue, Malaria). | 15 |
| **Total** | **75** |
| **Text Books** |
| 1 | Rangaswami G and Bagyaraj DJ (2002). Agricultural Microbiology. Second edition, PHI Learning (P) Ltd., New Delhi |
| 2 | Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co. |
| 3 | Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016. |
| **Reference Books** |
| 1 | . Adams, M.R and M.O. Moss (2005). Food Microbiology. 1st edition. Reprinted, Published byNew Age International (P) Ltd, Publishers-New Delhi. |
| 2 | Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4th edition, 2012. |
| 3 | Maier, R.M., Pepper, I.L. & Gerba, C.P. (2009). Environmental Microbiology. 2nd Ed. Academic Press. |
| 4 | Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013. |
| **Web Resources** |
| 1 | <http://www> ejb.org/content. |
| 2 | www. Biotech.kth.se Electronic Journal of biotechnology |
| 3 | [https://bio.libretexts.org/@go/page/9188](https://bio.libretexts.org/%40go/page/9188) |

**MAPPING WITH PROGRAMME OUTCOMES**

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|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 |  |  |  | M |  |  | L | M | L |  | M |
| CO2 |  |  |  | S |  |  | L | L | L |  |  |
| CO3 |  |  |  | S |  |  | M | M | L |  | M |
| CO4 |  |  |  | S |  |  | M | L | L |  |  |
| CO5 |  |  |  | S |  |  | M | L | L |  |  |

**APPLIED MICROBIOLOGY PRACTICAL**

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| **Subject Code** | **L** | **T** | **P** | **S** | **Credits** | **Instructional Hours** | **Marks** |
| **CIA** | **External** | **Total** |
| **23UMICEP2** |  |  | **2** |  | **1** | **2** | **25** | **75** | **100** |
| **Course Outcomes** |
| CO1 | Describe the techniques to estimate the quality of dairy products  |
| CO2 | Develop Skills in enzyme production  |
| CO3 | Microscopically analyze the morphological features of algae and root nodules bacteria |
| CO4 | Learn the methods available to check the water quality |
| CO5 | Understand the pathogenic bacteria in various sample  |
| **UNIT** | **Contents** | **No.of Hours** |
| I | Detection of bacteria in milk by SPC, Methylene Blue reduction test, Microscopic observation of curd  | 9 |
| II | Demonstration of enzymes producing bacteria (lipase, amylase, protease) | 9 |
| III | Azolla- morphological study, Isolation of Rhizobium from root nodules,  | 9 |
| IV | Enumeration of bacteria from water sample, test for coliforms by MPN method | 9 |
| V | Isolation of pathogenic bacteria from air, water, and food specimens | 9 |
| **Total** | **45** |
| **Text Books** |
| 1 | James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996. |
| 2 | Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications. |
| 3 | Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications. |
| 4 | Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi. |
| 5. | Rajan. S and Selvi Christy (2015). Experiments Procedure in Life Science, Anjanaa book House Publisers, Chennai |
| 6 |  R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing. |
| **Reference Books** |
| 1 | Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers. |
| 2 | Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India. |
| 3 | Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS. |
| 4 | Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication. |
| 5 | Lim D. (1998). Microbiology, 2nd Edition, WCB McGraw Hill Publications. |
| **Web Resources** |
| 1 | <http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403>. |
| 2 | <https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635> |
| 3 | [https://www.grsmu.by/files/file/university/cafedry//files/essential\_microbiology.pdf](https://www.grsmu.by/files/file/university/cafedry/files/essential_microbiology.pdf) |
| 4 | <https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology> |

**MAPPING WITH PROGRAMME OUTCOMES**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 | M |  |  |  |  |  |  |  |  |  |  |
| CO2 | M |  |  |  |  |  |  |  |  |  |  |
| CO3 |  |  |  | S | S | S |  |  |  |  |  |
| CO4 |  |  |  | S | S | S |  |  |  |  |  |
| CO5 |  |  |  |  | S | S |  |  | S |  |  |

**NME Courses offered to other Departments**

|  |  |  |
| --- | --- | --- |
| **SEMESTER: III****PART: IV** | **23UBTHN16:MUSHROOM TECHNOLOGY** **(NME - I)** | **CREDIT:2****HOURS:2** |

**Unit I Basic concepts of Mushroom Technology Hours:05**

Mushroom Technology - Introduction, History and Scope. Edible and Poisonous Mushrooms. Importance and nutritive value of edible mushrooms. Mushroom research centers in India

**Unit II Types of mushroom and its cultivation Hours:05**

Cultivation of button mushroom (Agaricus bisporus), milky mushroom (Calocybeindica), oyster mushroom (Pleurotus sajorcaju) and paddy straw mushroom (Volvariella volvcea)

**Unit III Production, Harvest and Storage methods Hours:05**

Isolation and culture of spores, culture media preparation. Production of mother spawn, multiplication of spawn - Inoculation Technique

**Unit IV Cultivation technology Hours:05**

Substrates, composting technology, bed, polythene bag preparation, spawning - Cropping and its importance

**Unit V Mushroom production Hours:04**

Harvest -types and Storage methods and post marketing surveillance and types.

**Text Books**

1. Krishnamoorthy, A.S et al. 1991. Oyster Mushrooms. 2nd edition. TNAU Department of Plant Pathology. Tamil Nadu
2. Suman, B C, and Sharma V P. 2007. Mushroom Cultivation in India. 1st edition. Daya Publishing House. India

**References**

1. NIIR Board of Consultants and Engineers. 2011. Handbook on Mushroom Cultivation and Processing.1st edition. Asia Pacific Business Press Inc. India
2. Biswas S. 2012. Mushrooms: A Manual for Cultivation. 1st edition. PHI Learning Private Limited. New Delhi
3. Thapa, C.D et al. 2017. Mushroom Culture. 1st edition. Agrimoon.com.
4. Russel, S. 2018. Essential guide to Mushroom Cultivation. 2nd edition. Storey

Publishing, United States

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| **SEMESTER: IV****PART: IV** | **23UBTHN26: ENVIRONMENTAL MANAGEMENT** **(NME II)** | **CREDIT:2****HOURS:2** |

**Unit I Ecology and Ecosystem Hours: 04**

Ecology - ecosystem and their types - definitions - environmental components and interrelationships - physical, chemical and biological characteristics of environment energy flow and materials cycling.

**Unit II Pollution Hours: 05**

Definition - source of pollution - types of pollution - air, water, soil, noise and radioactive pollution - environmental sanitation - environmental issues - global - national - regional and local

**Unit III Environmental Standards Hours: 05**

Prescribed environmental standards - WHO - Pollution Control Board – risk probability and hazards to humans - toxicology - chemical hazards – biological hazards: disease development and developing countries.

**Unit IV Pollution Control Methods Hours: 05**

Pollution control methods - physical, chemical and biological - waste water treatment - activated sludge process, oxidation ponds and trickling filter - anaerobic process.

**Unit V Environmental Management Hours: 04**

Tool for environment management - Environmental Impact Assessment – waste minimization techniques - environmental planning in urban development – natural resources and sustainable development - environmental ethics.

**Text Books**

1. Joseph, K. and Nagendra, R. 2004. Essentials of Environmental Studies. 2nd edition. Pearson Education. New Delhi
2. Tyler, M.J.R. 2004. Environmental Science. 2nd edition. Thomson Brooks/Cole Publishing. Singapore.

**References**

1. Dhamejam, S.K. 2005. Environmental Science and Engineering. 2nd edition. Kataria sons. Delhi
2. Dubey, R.C. 2006. Environmental Health Ecological Perspectives. 3rd edition. Jones and Bartlett Publishers. USA.

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| **SEMESTER: III****PART: III** | **CORE COURSE - V****23UBTHC33: IMMUNOLOGY AND IMMUNOTECHNOLOGY** | **CREDIT:5****HOURS:5** |

**Learning Outcome:**

Students will gain knowledge about the structure, functions and integration of immune system, immune response, reactions, cells involved in immunity, vaccines and tissue rejection.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Know the detailed description of the immune response made in humans to foreign antigens including microbial pathogens. |
| CO-2 | Know about the cells involved in the immune response either innate or acquired and how the immune system recognizes self from non-self. |
| CO-3 | Knowledge about the b and t cell maturation and specific responses. Other topics covered will include the genetic basis of diversity of immune responses in mammals. |
| CO-4 | Describe the cytokines and Vaccines production |
| CO-5 | To give an overview on hypersensitivity |

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| **SYLLABUS | Core Paper-5 | IMMUNOLOGY AND IMMUNOTECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | Introduction to Immunology. Cells involved in immune response. Primary and Secondary lymphoid organs – Thymus, Bone marrow, Lymph nodes and Spleen. Hematopoiesis – development of B and T lymphocytes. Types of immunity – Innate and acquired. | 10 |
| **II** | Antigen: Characteristics and types. Antibody – Structure, Types, Properties and their Biological Function. Production of antibodies- Hybridoma technology: Applications of Monoclonal antibodies in biomedical research. | 10 |
| **III** | Antigen – Antibody interactions, Immunodiffusion and Immuno electrophoresis. Principle and application of ELISA and RIA and Flourescent antibody technique and Western Blotting. Purification of antibodies. | 10 |
| **IV** | The complement system and activation and regulation. Types – Classical, alternative and Lectin pathway. Biological function of C’ proteins. Cytokines- Structure and Function. Vaccines – Types, Production and application. | 10 |
| **V** | Hypersensitivity Reactions and Types. Major Histocompatability Complex – MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules. HLA tissue typing. | 10 |
| **Reference Books**1. Thomas J. Kindt, Barbara A. Osborne and Richard A Goldsby, 2006. Kuby Immunology. 6th edition, W. H . Freeman and Company.
2. Kannan, I., 2010. Immunology. MJP Publishers, Chennai.
3. Abbas, A.K., A.H.L., Lihtman and S. Pillai, 2010. Cellular and Molecular Immunology, 6th Edition. Saunders Elsevier Publications, Philadelphia.
4. NandiniShetty, 1996, Immunology : introductory textbook – I. New Age International, New Delhi.
5. Fahim Halim K.,2009. The Elements of Immunology. Pearson Education.
6. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Roitt.s Essential Immunology, 12 edition, Wiley- Blackwell. USA.
7. Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition.
8. William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3rdEdition. John Wiley and Sons Inc. New York.
9. Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4thEdition., Wiley-Blackwell.
10. Noel R. Rose, Herman Friedman, John L. Fahey. (1986). Manual of Clinical Laboratory Immunology. ASM.3rd Edition.
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| **SEMESTER: III****PART: III** | **CORE COURSE - VI****23UBTHP34: PRACTICAL- LAB IN IMMUNOLOGY AND IMMUNOTECHNOLOGY** | **CREDIT:5****HOURS:5** |

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| **SYLLABUS | Core - 6 - Practical | LAB IN IMMUNOLOGY AND IMMUNOTECHNOLOGY** |
| **Content** |
| 1. Separation of Serum and Plasma.2. Blood grouping and Rh typing.3. WBC counting4. RBC counting5. Differential blood count6. WIDAL Slide test7. ASO test8. Double Immunodiffusion9. Single Radial Immunodifusion10. ELISA – Demonstration11. Handling of Laboratory animals - Demonstration12. Skin test – Demonstration |

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| **SEMESTER: III****PART: III** | **Elective – III** **23UBTHE35-BIO-INSTRUMENTATION** | **CREDIT:3** **HOURS:4** |

**Learning Outcome:**

Students will gain in-depth knowledge about analytical techniques and principles. They will gain expertise in handling instruments and understand their applications.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | To understand the concepts of the Microscopy techniques |
| CO-2 | Acquiring knowledge with the basic concepts of spectroscopic techniques |
| CO-3 | Acquiring knowledge with the basic concepts of chromatographic techniques |
| CO-4 | Acquiring knowledge with the basic concepts of Immunological techniques |
| CO-5 | Exploring towards the use of Centrifugation techniques |

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| **SYLLABUS | Allied Paper - 2 | BIOINSTRUMENTATION** |
| **Unit** | **Content** | **Hours** |
| **I** | pH – Definition – pH meter. Measurement of pH and calibration of pH meter - Buffers – Preparation of Buffers. Microscopy: Principle and applications of Compound, Bright field, Phase contrast and Fluorescence Microscope. | 6 |
| **II** | Spectra – Absorption and Emission Spectra – Beer Lambert’s law – Colorimeter, UV-Visible Spectrophotometer. Mass spectroscopy - Atomic absorption spectrometer (AAS) - Nuclear magnetic resonance spectrometer (NMR). | 7 |
| **III** | Chromatography - Principles – Paper Chromatography, TLC, Gel filtration, Ion-Exchange, Affinity Chromatography Gas Liquid Chromatography and HPLC. Electrophoresis: Principle, Paper Electrophoresis – Cellulose Acetate Electrophoresis - Agarose Gel Electrophoresis – SDS- PAGE and Iso-electric focusing. | 7 |
| **IV** | Radioactivity – Isotopes – Clinically important isotopes – Measurement of Radioactivity – GM Counters, Scintillation Counters – Autoradiography – Applications. SOPs for Radioactive materials. | 7 |
| **V** | Centrifugation – Principles - RCF, Sedimentation concept - - Different types of centrifuge – Types of rotors – Centrifugation types: Differential and Density gradient centrifugation – Ultra Centrifuge. | 7 |
| **Reference books:**1. Upadhyay and UpadhyayNath. (2009). “Biophysical Chemistry”, Principles and Techniques.Himalaya Publishing House.
2. L.Veerakumari, (2006) “Bioinstrumentation” MJP publishers , Kindle Edition.
3. SkoogD.A.F.James Holler and Stanky,R.Crouch, (2007) “Instrumental Methods of Analysis” Cengage Learning.
4. Palanivelu P, 2000. Analytical Biochemistry & Separation Techniques, 4th edition, Twenty first century publications.
5. Prakash M, 2009. Understanding Bioinstrumentation, 1st edition, Discovery Publishing House Pvt Ltd.,
6. Keith Wilson,John Walker,(2010).Principles and techniques of Biochemistry and Molecular Biology”(7th edition).Cambridge University Press.
7. David L.Nelson, Michael M Cox.Lehninger(2008).”Principles of Biochemistry”,Fifth edition W.H.Freeman,Newyork.
8. Khandpur R S, 2014. Handbook of Biomedical Instrumentation, 3rd edition, McGraw Hill Education (India).
9. L.A Geddes and L.E.Baker (2008) “Principles of Applied Biomedical Instrumentation”WileyIndia Third Edition.
10. Sharma B K, 2005. Instrumental Methods of Chemical Analysis, 24th Edition, GOEL Publishing House.
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| **SEMESTER: III****PART: III** | **23UBTHS36: Skill Enhancement Course - IV:– PRACTICAL- BIOINSTRUMENTATION** | **CREDIT:1** **HOURS:1** |

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| **SYLLABUS | Allied Practical - 2 | BIOINSTRUMENTATION** |
| **Content** |
| 1. Preparation of Buffer (Phosphate Buffer)2. Determination of pH of biological samples using pH meter 3. UV spectra of Nucleic acids and proteins.4. Chromatography analysis of sugar by paper chromatography.5. Chromatography analysis of amino acids by paper chromatography.6. Chromatography analysis of lipids by paper chromatography.7. Chromatography analysis of sugar by Thin layer chromatography.8. Chromatography analysis of amino acids by Thin layer chromatography9. Chromatography analysis of lipids by Thin layer chromatography10. Fractionation of biological material into its various components by Centrifuge. |

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| **SEMESTER: III****PART: IV** | **23UBTHS37: Skill Enhancement Course - V** **HERBAL BIOTECHNOLOGY**  | **CREDIT:2** **HOURS:2** |

**Learning Outcome:**

The paper imparts a fundamental of various systems of medicinal plant’s chemical constitution, screening and its standardization. To enable to students to know about the various technologies used in herbal preparations and concepts of crop cultivation methods.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand the various Indian systems of medicine |
| CO-2 | Understand the screening and characterization of herbal products. |
| CO-3 | To acquiring knowledge of the importance of medicinal plants |
| CO-4 | Acquiring traditional knowledge of medicinal plants and its chemical constituents |
| CO-5 | Understanding about the plants in day today life |

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| **SYLLABUS | Paper - 3 | HERBAL BIOTECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | History and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; Terminologies – Definitions – Classification of medicinal plants based on their effects – Ecological status with special reference to India. | 6 |
| **II** | Cultivation methods – Crop protection – Harvesting – Storage and Protection – Marketing and utilization - Export of medicinally important (General aspects). | 7 |
| **III** | Importance of medicinal plants – role in human health care – health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins). | 7 |
| **IV** | Traditional knowledge and chemical constitution and medicinal uses of the following herbs in curing various ailments; – *Solanum trilobatum,Cardiospermum halicacabum, Vitex negundo, Azadirachta indica, Aristolochia indica, Phyllanthus fraternus* and *Boerhaavia diffusa* | 7 |
| **V** | Plants in day today life – Ocimum sanctum, Centella asiatica, Aloe vera. Nutritive and medicinal value of some fruits (Guava, Sapota, Mango, Banana, Lemon) and vegetables - Greens (Moringa) Cabbage. | 7 |
| **Reference books:**1. Sinha, R.K., & Sinha, S. (2001). Ethnobiology. Jaipur: Surabhe Publications.
2. Pal, D.C., & Jain, S.K. (1998). Tribal medicine. Calcutta: Naya Prakash.
3. Jain, S.K. (1995). Contribution to Indian ethnobotany. (3rd ed.). Jodhpur: Scientific publishers.
4. Jain, S.K. (1995). A Manual of Ethnobotany. (2nd ed.). Jodhpur: Scientific publishers.
5. Sharma, A.K., Keservani, R.K., & Gautam, S.P. (2020). Herbal Product Development: Formulation and Applications. U.S: Auerbach Publications, CRC Press.
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| **SEMESTER: IV****PART: III** | **23UBTHP43: CORE - VII****PRACTICAL LAB GENETIC ENGINEERING AND rDNA TECHNOLOGY**  | **CREDIT:5** **HOURS:5** |

**Learning Outcome:**

Students will assimilate the concepts of genes, manipulation techniques involved in cloning and understand the applications in Genetic Engineering.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Correlate the role of restriction and modifying enzymes in recombinant DNA technology |
| CO-2 | Explore the techniques involved in construction of genomic DNA library and cDNA library |
| CO-3 | Design the protocols for analyzing gene transfer methods and to explore knowledge on hybridization based markers |
| CO-4 | Acquiring knowledge on DNA analysis techniques |
| CO-5 | Understand and describe the Applications in rDNA Technology |

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| **SYLLABUS | Core Paper - 7 | GENETIC ENGINEERING AND rDNA TECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | Genetic Engineering – Introduction. Tools in recombinant DNA technology – recombinant DNA – cloning strategies (enzymes, vectors, host) – introduction of rDNA into host cells. | 10 |
| **II** | Identification of recombinants, selection and screening for Recombinants. DNA sequencing – Construction of Genomic DNA library and cDNA library), Chromosome walking. Human Genome Project. Polymerase Chain reaction- Methodology and its Types. | 10 |
| **III** | Gene transfer techniques – Viral mediated gene transfer, Selectable markers and reporter genes - Non viral mediated gene transfer - Physical methods: Microinjection - Electroporation - Particle Bombardment, Chemical methods: Calcium phosphate - DEAE dextran - Liposomes. | 10 |
| **IV** | Gene Expression – Expression system and their applications - protein based products – Protein engineering– production of protein from cloned genes. Site directed Mutagenesis, Restriction Fragment Length Polymorphism (RFLP). | 10 |
| **V** | Application of Recombinant DNA technology in medicine, industry, agriculture and r-DNA technology - merits and demerits. | 10 |
| **Reference books:**1. Brown T.A, 2015. Gene Cloning and DNA Analysis: An Introduction, 7th edition, Wiley - Blackwell.
2. Desmond S.T. Nicholl, 2008. An Introduction to Genetic Engineering, 3rd edition, Cambridge university press.
3. R.W. Old & S.B. Primrose, Principles of Gene Manipulation, Fifth Edition, Blackwell Science.
4. Genetic Engineering Principles and Methods by Setlow, Jane K. (Volume 24).
5. Keya Chaudhuri, 2012. Recombinant DNA Technology.
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| **SEMESTER: IV****PART: III** | **23UBTHP44: CORE – VIII PRACTICAL – LAB** **GENETIC ENGINEERING AND rDNA TECHNOLOGY**  | **CREDIT:5** **HOURS:5** |

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| **SYLLABUS | Core – 8- Practical | LAB IN GENETIC ENGINEERING AND rDNA TECHNOLOGY** |
| **Content** |
| 1. Isolation of genomic DNA 2. Isolation of plasmid DNA3. Isolation of RNA4. Production of competent cells for transformation5. Bacterial transformation6. Restriction Digestion of DNA7. Restriction Fragment Length Polymorphism (DEMO) 8. PCR (Demonstration). |

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| **SEMESTER: IV****PART: III** | **23UBTHE45:** **ELE- IV BIOINFORMATICS AND BIOSTATISTICS**  | **CREDIT:3** **HOURS:3** |

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| **Learning Objective** |
| LO1 |  Acquire knowledge about the Developments and Applications of Bioinformatics. |
| LO2 |  Gain knowledge about the importance of the bioinformatics, databases, tools and software of bioinformatics and explain different types of Biological Databases. |
| LO3 | Understand the basics of sequence alignment, sequence analysis and Protein structure prediction method. |
| LO4 | Demonstrate the basic methods of data collection, graph construction and sampling techniques and Calculate measures of central tendency  |
| LO5 |  Correlate and analyze biological data through various statistical methods and interpret biological data via various probabilistic distribution methods. |
| **UNIT** | **Contents** | **No.of Hours** |
| I | Introduction to Bioinformatics – Genome, Transcriptome and Proteome, Gene prediction rules and software. Nucleic acid Databases – Primary and Secondary Databases – Structure Database – CATH, SCOP – Data base Searching – BLAST and FASTA, BLOSSUM. | 8 |
| II | Sequence analysis (Proteins and Nucleic acids), Protein Database: Comparison of Protein sequences and Database searching – methods for protein structure prediction - Homology modeling of proteins, visualization tools (RASMOL). | 8 |
| III | Multiple Sequences alignment – method of multiple sequences alignment- Evolutionary analysis, clustering methods Phylogenic trees - Methods to generate phylogenetic tree- Tools for multiple sequences alignment and phylogenetic analysis - History of Drug Discovery, Steps in Drug design - Chemical libraries – Role of molecular docking in drug design.  | 10 |
| IV | Statistics – collection, classification, tabulations of Statistical Data – Diagrammatic representation – Graphs – Sampling method and standard error. Measures of central tendency – measures of dispersion. | 7 |
| V | Correlations and regression. Probability distribution-Binomial, Negative binomial, multinomial distribution, Poisson distribution. Tests of significance – t tests – F tests – Chi square test. Analysis of variance – Statistical Soft wares. | 7 |

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| **Text Books** |
| 1 | Pennington, S.R. and Punn, M.J. 2002.Proteomics: from protein sequence to function. Viva books Pvt. Ltd. |
| 2 | Shuba G.,2010. Bioinformatics., Tata McGraw Hill publishing.India. |
| 3 | Rastogi, S.C, Mendiratta, N,Rastogi, P., 2004. Bioinformatics methods and application. Prentice-Hall of India private limited, New Delhi. |
| 4 | N.Gurumani (2011) "An Introduction to Biostastistics" MJP Publishers |
| 5 | VerbalaRastogi .(2011).”Fundamentals of Biostatistics”, Ane books Pvt Ltd Publishers,Chennai. |
| **Reference Books** |
| 1 | Attwood, T.K. and Parry-Smith, D.J.2008. Introduction to Bioinformatics. Pearson Education. |
| 2 | David Mount., Bioinformatics: sequence and genome analysis, second edition., Taylor & Francis, UK; 2009. |
| 3 | D.R.Westhead. Instant Notes in Bioinformatics., second edition., Taylor & Francis, UK; 2009. |
| 4 | Zar,(J.H.2010).”Biostatistical Analysis” Fifth Edition, Pearson Education Pvt Ltd, Indian Branch,NewDelhi. |
| 5 | P.N.Arora and P.K. Malhan.(2013)"Biostatistics"Himalaya publishing House. |

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| **SEMESTER: IV****PART: III** | **23UBTHS46: SEC-6 PRACTICAL - BIOINFORMATICS AND BIOSTATISTICS**  | **CREDIT:2** **HOURS:2** |

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| **Learning Objective** |
| LO1 |  Analyse the Biological databases |
| LO2 | Able to perform BLAST and FASTA  |
| LO3 | Represent data in to graphical form |
| LO4 | Test the level of significance of biological data and interpret the results. |
| LO5 | Determine averages of the biological data |
|  **Contents** |
| 1. Biological databases (NCBI, Swissprot and PDB)2. BLAST FASTA3. Identification of functional domains in nucleotide binding proteins using a domain analysis server like SMART4. Preparation of bar diagram, line diagram and pie diagram using MS EXCEL.5. Calculation of Central tendency- mean, geometric mean, median using MS EXCEL.6. Calculation of dispersion – Mean deviation, quartile deviation and standard deviation using MS EXCEL7. Calculation of student’s t test using MS EXCEL |

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| **SEMESTER: IV****PART: IV** | **23UBTHS47: Skill Enhancement Course - VII** **VERMICULTURE** | **CREDIT:2** **HOURS:2** |

**Learning Outcome:**

The paper imparts a basic knowledge on diversity and economic importance of earthworms. Acquires knowledge the common species for vermiculture, applications of Vermiculture Biotechnology and Marketing the products of vermiculture.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand the ecological grouping of earthworms and its economic importance |
| CO-2 | Acquires knowledge about the indoor and outdoor cultures of common species of earthworms. |
| CO-3 | Provide adequate knowledge of the applications of earthworms for waste management. |
| CO-4 | Knowledge about the packaging and transport of vermiculture products |
| CO-5 | Provide the knowledge of vermi-composting future perspectives |

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| **SYLLABUS | Paper - 4 | VERMICULTURE** |
| **Unit** | **Content** | **Hours** |
| **I** | Taxonomic position and diversity - Types: morphological and ecological grouping - Ecological roles and economic importance of earthworms - need for earthworm culture. | 6 |
| **II** | Definition, scope and importance - common species for culture - Environmental requirements - culture methods - wormery breeding techniques - indoor and outdoor cultures - monoculture and polyculture - relative merits and demerits. | 6 |
| **III** | Vermin-composting, use of vermicastings in organic farming / horticulture - earthworms for management of biomedical solid wastes - feed / bait for capture / culture fisheries – forest regeneration. | 6 |
| **IV** | Quality control, market research, marketing techniques - creating the demand by awareness, demonstration, and advertisements - packaging and transport - direct marketing. | 5 |
| **V** | Future perspectives - Predator / pathogen control in wormeries - Cost-benefit analysis of vermi-composting - Potentials and constraints for vermiculture in India. | 6 |
| **Reference books:**1. Ismail, S.A. (2005). The Earthworm Book. Second Revised Edition. Goa: Mother India Press.
2. Edwards, C.A., & Bohlen, P.J. (1996). Ecology of earthworms. (3rd ed.). UK: Chapman and hall.
3. Ismail, S.A. (1970). Vermicology: The biology of earthworms. London: Orient Longman.
4. Lee, K.E. (1985). Earthworms - Their ecology and Relationship with Soil and Land use. Sydney: Academic Press.
5. Clive, A.E., Norman, Q.A., & Rhonda, L.S. (2011). Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management. (1st ed.). Boca Raton (Florida): CRC Press.
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| **SEMESTER: V****PART: I** |  **23UBTHC51: CORE - IX****PLANT BIOTECHNOLOGY** | **CREDIT:4** **HOURS:5** |

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**Learning Outcome:**

Students will gain knowledge about plant tissue culture, transgenic plants, nitrogen fixation mechanism and significance of viral vectors.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand and recall the working principle of plant tissue culture and molecular techniques. |
| CO-2 | Knowledge about the plant growth hormones and its uses. |
| CO-3 | To understand the techniques of Micropropagation  |
| CO-4 | Understand knowledge about the Agrobacterium mediated gene transfer |
| CO-5 | Describe the ecological impact of transgenic plants. |

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| **SYLLABUS | Core Paper - 9 | PLANT BIOTECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | History of plant biotechnology, Conservation of Plant using Biotechnology. Plant genome organization: structural features of a representative plant gene, gene families in plants. Organization of chloroplast genome and mitochondrial genome. | 10 |
| **II** | Auxins, cytokinins and gibberlins – molecular basis of action – phytochrome – role in photomorphogeneisis – abscisic acid – and stress – induced promoter switches in the control of gene expression – Ethylene and fruit ripening. | 10 |
| **III** | Media composition (MS media) - Micropropagation techniques - direct and indirect organogenesis - somoclonal variation - somatic embryogenesis - haploid and triploid - Protoplast isolation, fusion and culture - hybrid and cybrid production, Synthetic seed production. Secondary metabolite production. | 10 |
| **IV** | Agrobacterium and crown gall tumors – Mechanism of T-DNA transfer to plants, Ti and Ri Plasmid vectors and their utility – Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia, nif gene. | 10 |
| **V** | Crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Transgenic plants- plant vaccines, genetically modified food - future perspectives & ecological impact of transgenic plants. | 10 |
| **Reference Books**1. Sudhir, M. 2000. Applied Biotechnology and plant Genetics. Dominant publishers and distributors.
2. Trivedi, P.C.2000. Applied Biotechnology: Recent Advances. PANIMA Publishing corporation.
3. Ignacimuthu. 1996. Applied Plant Biotechnology. Tata McGraw – Hill.
4. Narayanaswamy S. 1994. Plant cell and tissue culture. Tata McGraw Hill Publishing Company limited, New Delhi.
5. Chawla, H.S., “Introduction to Plant Biotechnology”, 3rd Edition, Science Publishers, 2009.
6. Kojima, Lee, H. and Kun, Y. 2001. Photosynthetic microorganisms in Environmental Biotechnology. Springer – Verlag.
7. Stewart Jr., C.N., “Plant Biotechnology and Genetics: Principles, Techniques andApplications” Wiley-Interscience, 2008.
8. Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.
9. Trigiano, R.N. and Gray, D.J. 1996. Plant tissue culture concepts and laboratory exercise. CRC Press. BocaRatin, New York.
10. Street, H.E. 1977. Plant tissue culture. Blackwell Scientific Publications, oxford, London.
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| **SEMESTER: V****PART: II** |  **23UBTHC52: CORE - X****ANIMAL BIOTECHNOLOGY** | **CREDIT:4** **HOURS:5** |

**Learning Outcome:**

On successful completion of the course, students will gain knowledge in the concepts of animal and medical biotechnology. They will acquire the skill and confidence to set up an animal tissue culture laboratory. They will learn the molecular techniques in diagnosis and understand the production of vaccines.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand scientific and technical skills on animal study |
| CO-2 | Acquire knowledge on limitations and challenges in animal cell tissue culture |
| CO-3 | Know about animal products |
| CO-4 | Learn the preservative methods of cells |
| CO-5 | Evaluate and discuss public and ethical concerns over the use of animal Biotechnology |

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| **SYLLABUS | Core Paper - 10 | ANIMAL BIOTECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | Animal cell culture – History and development, Pluripotency, Media, balanced salt solutions, Physical, chemical and metabolic functions of constituents of culture media, Role of carbon dioxide, Serum, growth factors and amino acids in media. Serum containing and serum free media. Constitution of a media for cell line. Essential equipments required for animal cell culture. | 10 |
| **II** | Types of cell culture- Primary, Secondary, Organ culture and cell lines. Role of feeder layers in cell culture, Cell separation techniques, cell synchronization, Cell counting methods, cryopreservation, Cell banking procedures. Biology of cultured cells- Apoptosis and cell death. | 10 |
| **III** | Transfection of cells in culture- Animal viral vectors for transfection, Physical methods of transfection, HAT selection, selectable markers. Micro manipulation of cells, Gene targeting, gene silencing and Gene knockout and their applications. | 10 |
| **IV** | Protein production by genetically engineered mammalian cell lines, Stem cells and their applications-; Cell culture as a source of valuable products -Transgenic Animals. | 10 |
| **V** | Collection and preservation of embryos, Semen banking, AI, IVF and ICSI. Case Study-any two relevant studies. | 10 |

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| **Reference Books*** + - 1. R. Ian Freshney, Culture of Animal cells – A Manual of Basic Technique Fourth Edition, WILEY LISS & Publications.
			2. Glick, B.R. and Pasternark. 2002. Molecular Biotechnology: Principle and applications of recombinant DNA.
			3. Ramasamy.P. 2002.Trends in Biotechnology, University of Madras of Publications, Pearl Press
			4. Dr.C.K.Leach, Invitro cultivation of Animal cells Butterworth and Heinemann Ltd.1994.
			5. Kreuzer, H. and Massey, A. 2001. Recombinant DNA and Biotechnology: A guide for teachers, 2nd edition. ASM Press Washington.
			6. Traven. 2001. Biotechnology. Tata McGraw – Hill.
			7. Walker,J.M. and Gingold, E.B. 1999.Molecular biology and Biotechnology, 3rdedition. Panima Publishing Corporation.
			8. Ignacimuthu. 1996. Basic Biotechnology. Tata McGraw-Hill.
1. Puhler, A.V.C.H. 1993. Genetic engineering of Animals. VCH Publishers, Weinbeim, FRG.
2. Watson, J.D., Gilman, M., Witknowski, J. and Zoller, M. 1992. Recombinant DNA (2nded) Scientific American Books, NY.
3. Murray, E.T. 1991. Gene transfer and expression protocols – Methods in Molecular biology Vol.7. Humana Press.
4. Watson, J.D., Hopkins, N.H., Roberts, J.W. Steitz, J.A. and Weiner, A.M. 1987.Molecular biology of gene. Benjamin/ Cummings 4th Ed. Vol.1&2.
5. K. Srivastava et al., 2009, Animal Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd.
6. Bob Old and S.B. Primrose, 1994, 5th Ed, Principles of Gene Manipulation, Wiley-Blackwell Scientific Publications
7. B.C. Currell et al., 1994, In vitro Cultivation of Animal Cells (Biotol), Butterworth-Heinemann Ltd.
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| **SEMESTER: V****PART: III** | **23UBTHC53-CORE - XI** **ENVIRONMENTAL & INDUSTRIAL BIOTECHNOLOGY** | **CREDIT:4** **HOURS:5** |

**Learning Outcome:**

This course is planned to provide the learner an idea about Global environmental changes, Biotechnological methods of handling recent environmental problems and the students to explore the beneficial potentials of microbes in the fermentation industry.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand the knowledge of biotechnological approaches in environmental pollutions. |
| CO-2 | Provide the knowledge of biotechnological applications in waste treatment |
| CO-3 | Describe the various Bioprocess Engineering and its step involved for bioreactors |
| CO-4 | Understand the knowledge of Downstream processing and its applications  |
| CO-5 | Demonstrate the metal leaching and steps involved in the process |

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| **SYLLABUS | Core Paper - 11 | ENVIRONMENTAL & INDUSTRIAL BIOTECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | Environmental Pollution – Sources and types - Water, Air, Thermal, Industrial and Radiation - Global environmental changes. Global warming, Greenhouse effect, acid rain, ozone depletion, and photochemical smog. Environmental issues, management strategies and safety, Biotechnological approaches for management. | 10 |
| **II** | Waste water treatment: Aerobic and anaerobic methods (Primary, Secondary and Tertiary) –Use of aquatic plants in waste water treatment. Solid waste management. Bioenergy and SCP from waste. Drinking water treatment. Biotechnological approach to industrial effluent (Paper, Tannery, Textile) Pesticide waste disposal. | 10 |
| **III** | Bioprocess Engineering- Steps in bioprocess development. Design of bioreactors - Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Bioreactor configurations and types: Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Animal and plant cell bioreactors. Factors affecting broth viscosity, Mixing in Fermenters. Fermentation systems Batch culture, Continuous culture, Fed-batch culture | 10 |
| **IV** | Downstream processing Filtration, Centrifugation, Cell disruption, Liquid-liquid extraction, Chromatography, membrane processes, Drying, Crystallization, Whole broth processing. Different types of fermented foods produced from microorganisms- Idli, Sauerkraut - Dairy products- Cheese and Yoghurt. Microbial biomass, Microbial enzymes– Amylase & protease, Immobilization of enzymes: Methods, Properties, Applications, Advantages and Disadvantages of Immobilization, Biosensors and Biochips -Types and applications. Microbial Polysaccharide production: Xanthan, Dextran. | 10 |
| **V** | Ore leaching (methods and examples), MEOR, Production of antibiotics – Penicillin - streptomycin. Alcoholic beverages: Wine, Beer –Biofertilizers- Rhizobium & Azotobacter. Biopesticides – Bacillus thuringiensis and microbial toxin production and their applications - Biosurfactants, Vitamins- Folic acid & Vitamin B12, Organic acids. | 10 |
| **Reference Books**1. Alan Scragg, 1999. Environmental Biotechnology, Pearson Education Limited, England, 2. Eugene P. Odum, 1972. Fundamentals of Ecology, W.E. Saunders Company, London, 3. Metcalf and Eddy, 1979. Wastewater Engineering – Treatment Disposal and Reuse Inc., Tata McGraw Hill, New Delhi.4. Crosby and Donald G, 1998. Environmental Toxicology and Chemistry, Oxford University Press.5. Chatterji, A.K., 2002. Introduction to Environmental Biotechnology, Prentice-Hall of India, New Delhi.6. Anil Kumar De., 2000. Environmental Chemistry, 4th Edition. New Age International, New Delhi.7. Murugesan, A G., Rajakumari, C., 2005. Environmental Science and Biotechnology Theory and Techniques., MJP publishers, Chennai.8. Peter F. Stanbury, Allan Whitaker, Stephen J. Hall (2013). Principles of Fermentation Technology Second Edition, .Elsevier Science Ltd9. Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higton (2001.), Industrial Microbiology: An Introduction. . Blackwell Science Ltd10. Nduka Okafor, Modern Industrial Biotechnology & Microbiology (‎2017), Science Publishers, Edenbridge Ltd.11. H.J. Peppler and D. Perlman, Microbial Technology (1979) .Vol 1&2 . Academic Press.12. L E Casida, Industrial Microbiology (1968) Jr. John Wiley and Sons Inc.13. Waites, Morgan, Rockey and Higton, Industrial Microbiology: An Introduction, Blackwell Science (2001).14. Madigan, Michael and Martinko, John, Brock biology of microorganism, 11th edition, (2005).15. H. Scott Fogler, Elements of Chemical Reaction and Engineering, 4 th edition, by Pearson Education Inc., (2006). 16. E.M.T.El-Mansii, , (2011) Fermentation Microbiology and Biotechnology, Third Edition.17. T.Satyanranyana, Bhavdish Narain Johri,Anil Prakash (2012), Microorganisms in Sustainable Agriculture and Biotechnology. |

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| **SEMESTER: V****CORE - XII****PART: III** | **23UBTHD54****PROJECT WITH VIVA-VOCE** | **CREDIT:4** **HOURS:5** |

**Learning Outcome:**

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of pursuing research.

**Refer to regulations for additional Information**

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| **SEMESTER: V****PART: III** | **23UBTHE55- Elective – V** **Practical V– Plant Biotechnology and Animal Biotechnology** | **CREDIT:3** **HOURS:4** |

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| **Learning Objectives** |
| LO1 | Explain plant tissue culture and Illustrate Callus development. |
| LO2 | Develop technical skills in Protoplast isolation and Nucleus localization. |
| LO3 | Make use of the techniques used in preparing tissue culture medium and membrane filtration in culturing animal cells and prepare single cell suspension and evaluate cell counting and viability. |
| LO4 | Develop technical skills in isolation of DNA and RNA from plants and microorganisms. |
| LO5 | Examine the importance of trypsinization in monolayer and subculture and cryopreservation. |
| **Contents** |
| 1. Plant tissue culture media preparation & sterilization techniques.2. Callus induction3. Isolation of plant protoplast & viability test.4. Localization of nucleus using nuclear stain.5. Preparation of Animal Tissue culture medium and membrane filtration6. Preparation of Single Cell Suspension & Cell counting.7. Cell viability Test8. Isolation of plant DNA and plant RNA(Demo)9. Isolation of Agrobacterium plasmid DNA (Demo)10. Trypsinization of monolayer and subculturing (Demo)11. Measurement of phagocytic activity (Demo)12. MTT Assay (Demo)13. Cryopreservation and thawing (Demo) |

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| **SEMESTER: V****PART: III** | **23UBTHE56 Elective VI** **Practical VI– Environmental And Industrial Biotechnology** | **CREDIT:3** **HOURS:4** |

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| **Learning Objective** |
| LO1 | Students can able to isolate the microorganisms and determine their growth curve, generation time. |
| LO2 | To analyze the water samples, perform immobilization and production of Wine, Biogas and compost. |
| LO3 | Develop skills in bio fertilizer production and microbial identification. |
| LO4 | Gain basic skills to analyze raw milk and determine the pasteurization efficacy.  |
| LO5 | Develop skills to perform efficiency tests of bio fertilizers and bio pesticides, microbial polysaccharide production. |
| **Contents** |
| 1. Isolation of Air borne Pathogens2. Study of Growth Curve and Generation time of Bacteria/ Yeast using turbidometry.3. Water analysis – MPN and BOD.4. Immobilization of whole yeast cells/ enzyme by Alginate beads.5. Production of wine6. Production of Biogas – *In vitro* & Compost Making.7. Biofertilizer production/Spirulina production - field visit. (Report should be included in the record)8. Isolation and identification of starter organisms from Idli batter/ curd9. Grading of raw milk (Dye reduction test).10. Determination of efficiency of Pasteurization by quantitative phosphatase test.11. Preparation and Efficiency testing of Biofertilizer/ Biopesticide. (Demo)12. Production of microbial Polysaccharide. (Demo) |

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| **SEMESTER: V****PART: IV** | **23UBTHI58** **SUMMER INTERNSHIP** | **CREDIT:2** **HOURS:-** |

**(Refer to the Regulations)**

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| **SEMESTER: VI****PART: I** | **23UBTHC61 CORE - XIII****FOOD TECHNOLOGY** | **CREDIT:4** **HOURS:6** |

**Learning Outcome:**

The paper imparts for the student will be able to understand the basic concepts of food industry and evolution of food processing. The learner will be able to analyze the structure, composition of food and food safety.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand the bio process engineering in biotechnology industry |
| CO-2 | Classify food based on its properties. |
| CO-3 | Understand the microbiological changes that occur during the processing and preservation of food. |
| CO-4 | Differentiate between processed and spoiled food |
| CO-5 | Become a food technologist or a food analyst. |

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| **SYLLABUS | Core Paper – 13 | FOOD TECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | Biotechnology relating to the food industry – Role of bio process engineering in biotechnology industry- Regulatory and social aspects of biotechnology in foods- Application of biotechnology in waste treatment of food industries. Historical evolution of food processing technology. | 10 |
| **II** | Properties of foods – cereals, pulses, nuts, oilseeds, milk, and animal foods (egg, fish, and meat), Change during cooking. Gelatinization, denaturation, fermentation, nonenzymatic browning. Rancidity – types and prevention.  | 10 |
| **III** | Food as a substrate for micro-organisms- pH and Moisture requirements, the concept of water activity, oxidation-reduction potential, nutrient content, inhibitory substances, bacterial growth curve, and factors affecting the growth of microorganisms. | 10 |
| **IV** | General principles of spoilage, fitness or unfitness of food for consumption, causes of spoilage, classification of spoiled foods, chemical changes caused by microorganisms in food, and important food spoilage bacteria in plant and animal-based foods. | 10 |
| **V** | Government regulations and international standards and policies on food sampling and sample preparation- selection of sampling procedures, preparation of samples. Rheological principles of food analysis, analysis of food emulsions. | 10 |
| **Reference Books**1. Bawa. A.S, O.P Chauhan etal. Food Science. New India Publishing agency, 2013
2. Roday,S. Food Science, Oxford publication, 2011.
3. B. Srilakshmi, Food science, New Age Publishers,2002
4. Meyer, Food Chemistry, New Age,2004 5. De Sukumar., Outlines of Dairy Technology, Oxford University Press, 2007
5. Joshi, V.K. and Singh, R.S., A. (2013), Food Biotechnology- Principles and practices, I.K.International Publishing House Pvt. Ltd., New Delhi,.
6. RavishankarRai, V,( 2015), Advances in Food Biotechnology, (First edition), John Wiley & Sons, Inc, ISBN 9781118864555.
7. Foster, G.N., (2020), Food Biotechnology, (First edition), CBS Publishers & Distributors Pvt Ltd, ISBN 9789389396348.
8. Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin (2005), Food Biotechnology, (2nd edition), CRC Press,ISBN 9780824753290.
9. Perry Johnson-Green.( 2018), Introduction to Food Biotechnology, Special Indian Edition, CRC Press, ISBN 9781315275703.
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| **SEMESTER: VI****PART: II** | **23UBTHC62** **CORE - XIV****PHARMACEUTICAL BIOTECHNOLOGY** | **CREDIT:4** **HOURS:6** |

**Learning Outcome:**

Students will understand the series of processes involved in drug development, patenting and drug approval.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand and evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market |
| CO-2 | Acquire knowledge on novel biotechnological and Biopharmaceuticals Industrial development. |
| CO-3 | Understanding of current topical and newly emerging aspects of pharmaceutical biotechnology |
| CO-4 | Understand the legal steps involved in progressing a new drug to market. |
| CO-5 | Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries. |

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| **SYLLABUS | Core Paper – 14 | PHARMACEUTICAL BIOTECHNOLOGY** |
| **Unit** | **Content** | **Hours** | **COs** | **Cognitive level** |
| **I** | Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Drug designing - Drug production - Preclinical trials - Clinical trials - Pharmacokinetics and Pharmacodynamics - Patenting & Drug Approval - Drug Marketing - Post clinical trials | 10 | CO1 | K1&k2 |
| **II** | Production of recombinant proteins - Development of Nucleic acid based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery - Pharmacognacy . | 10 | CO2 | K1,K2 & K3 |

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| **III** | Human Insulin (Humulin), Growth hormones (Humatrope) - Blood coagulating factor (factor VIII - Kogenate) - Erythropoietin - (Epogen) Granulocyte colony stimulating factors (Neulasta) - Interferons (Avonex) - Antimicrobial peptides (β - defensin 2) - Vaccines (Pentavac), Biologics (Humira - Adalimumab), - Cancer based biologics (rituximab). | 10 | CO3 | K1,K2 & K3 |
| **IV** | Drug toxicity analysis - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management | 10 | CO4 | K1,K2 & K3 |
| **V** | National and International Drug approval agencies - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors. | 10 | CO5 | K1,K2 & K3 |
| **Reference Books*** + - 1. Gary Walsh (2003), Biopharmaceuticals ; biochemistry and Biotechnology, John Wiley & Sons Ltd.
			2. Oliver Kayser and Heribert Warzecha (2012), Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Wiley - Blackwell.
			3. Simon Wills, 2nd Edition (2005), Drugs of abuse, Pharmaceutical Press
			4. Chandrakant Kokate and Pramod H.J 1st Edition (2011), Text Book of Pharmaceutical Biotechnology, Elsevier
			5. Crommelin, Dean J. A., Sindelar, Robert, Meobohm, Bernd (Eds.) (2019), Pharmaceutical Biotechnology: Fundementals and Applications, Springer.
			6. Ashish Dixit, Pawan Tiwari and Vivekanand Kishan Chatap (2015), Textbook of Pharmaceutical Biotechnology, Studium Press (India) Pvt. Ltd.
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| **SEMESTER: VI****PART: III** | **23UBTHC63** **CORE - XV****AQUACULTURE BIOTECHNOLOGY** | **CREDIT:4** **HOURS:6** |

**Learning Outcome:**

Students will gain knowledge about Marine aquaculture and freshwater aquarium fishes and application of biotechnology in different aspects of aquaculture.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand the scope of aquatic biotechnology as an emerging field |
| CO-2 | Learn feed biotechnology, active compounds and proteins |
| CO-3 | Acquires knowledge of the marine aquaculture and ornamental fish keeping |
| CO-4 | Understand the molecular diagnostic technologies in aquatic biotechnology |
| CO-5 | Gain knowledge of the economically importance of aquaculture |

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| **SYLLABUS | Core Paper – 15 | AQUACULTURE BIOTECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | Introduction - Scope of biotechnology in fisheries and aquaculture research. Transgenics – Principles of transgenic technology and its application in fisheries, Synthetic hormones for induced breeding. | 10 |
| **II** | Probiotics, single cell proteins, nutraceuticals. Commercial Recombinant protein - enzymes, hormones, bioactive compounds, therapeutic proteins. Antimicrobial peptides and their applications. Marine toxins. | 10 |
| **III** | Marine aquaculture – sea ranching, cage culture, raft culture, rope culture, pen culture. Culture technique of shrimps. Ornamental fish keeping - Common characters and sexual dimorphism of Fresh water aquarium fishes such as Guppy, Molly, Swordtail, Goldfish, Angelfish, Blue morph and Butterfly fish. Live feed organisms, General Aquarium maintenance. | 10 |
| **IV** | PCR protocol for white spot syndrome virus WSSV, Infectious hypodermal and hematopoietic necrosis virus IHHNV, Yellow head disease YHD, Taura syndrome virus TSV. Electron microscopy in advanced fisheries research. Cryomicroscopy in aquaculture research. | 10 |
| **V** | Economically important freshwater and marine organisms - fishes, crabs, oyster, shrimp, lobster, mussels. Importance of Fishery products and by - products. | 10 |
| **Reference Books**1. Nagabhushanam, R. (2004). Biotechnology of Aquatic Animals. (1st ed.). Boca Raton: CRC Press.
2. Singh, B. (2006). Marine Biotechnology and Aquaculture Development. New Delhi: Ane Books Pvt. Ltd.
3. Felix, S. (2007). Molecular diagnostic technology in aquaculture. New Delhi: Narendra Publishing House.
4. Pandian, T.J., Strüssmann, C.A., & Marian, M.P. (2005). Fish Genetics and Aquaculture Biotechnology. (1st ed.). Boca Raton: CRC Press.
5. Fingerman, M., Nagabhushanam, R., & Thompson, M.F. (1997). Recent Advances in Marine Biotechnology. (1st ed.). Boca Raton: CRC Press.
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| **SEMESTER: VI****PART: III** | **ELECTIVE – VII** **23UBTHE64-1** **ENVIRONMENT MANAGEMENT IN INDUSTRIES** | **CREDIT:3** **HOURS:5** |

**Learning Outcome:**

The students will understand the dairy processing technologies, types of workplace hazards and apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological and psychosocial hazards.

**Course outcomes**: At the end of the Course, the Student will be able to:

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| CO-1 | Understand the Simulation of biological systems |
| CO-2 | Knowledge about the diary industries and managements applications. |
| CO-3 | Describe on Agribusiness and applications of marketing research |
| CO-4 | Learn about the Hazards and Personal Protection Approaches. |
| CO-5 | Understand the Occupational Health & Industrial Hygiene |

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| **SYLLABUS | Elective - III – 1 | ENVIRONMENT MANAGEMENT IN INDUSTRIES** |
| **Unit** | **Content** | **Hours** |
| **I** | Introduction to life science, computer in life science-Medical imaging, Genomics and phylogenetics, Drug design and discovering, Assistive robotics, Brain-computer interfaces, Simulation of biological systems and Medical treatment optimization. | 7 |
| **II** | Introduction to Dairy industries, The Structure of Dairying in Developing Countries, Application of Computer in Dairy Industry, Milk Procurement & Billing, Plant Automation, Computerized Accounting System, Applications of Management Information System (MIS), Packaging, Supply Chain Integration and Traceability. | 7 |
| **III** | Agribusiness - Application of marketing and decision making in contemporary agribusiness firms. Marketing strategies, marketing research and information, segmentation and targeting, Professional selling skills and knowledge – Rural Development – NABARD. | 7 |
| **IV** | Hazards in the workplace: Pressure, Biological, Chemical, Electricity, Fire, Heat & Cold, Indoor Air Quality, Lighting, Noise, ergonomics, Radiation (ionizing & non ionizing), Vibrations, hours of work, violence in work place, Understanding of Material Safety Data Sheets, Accidents and Safety Management: Accident Prevention methods, Safety Management and audit, Personal Protection Approaches. | 7 |
| **V** | Occupational Health & Industrial Hygiene: Scientific and engineering basis for occupational health, biological monitoring (e.g. BEI), Occupational Hygiene, Concept of First Aid, Preventive Measures, and Occupational Health & Safety Management System: OHSAS – 18000. | 7 |
| **Reference Books**1. LalatChander, 2010. Text book of Dairy Plant Layout and Design, ICAR, New Delhi.
2. Larry R. Collins, 2001.Physical Hazards of the Workplace, CRC Press, Taylor&Francis group.
3. Andrew Barkley, 2013, Principles of Agricultural Economics, Taylor&Francis group.
4. Mishra R.K., 2015. Occupational health management, Aitbs Publishers and Distributors- Delhi.
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| **SEMESTER: VI****PART: III** | **ELECTIVE – VII** **23UBTHE64-2** **MARINE BIOTECHNOLOGY** | **CREDIT:3** **HOURS:5** |

**Learning Outcome:**

Students will gain knowledge about Marine Resources, Pharmacology and byproducts for Aquaculture and commercial development.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understanding the significance and importance of marine micro biota |
| CO-2 | Basic Knowledge on biodegradation and bioremediation marine ecosystem pollutants |
| CO-3 | Understand the principles of bio fouling |
| CO-4 | Acquiring knowledge of genetic modifications marine organisms. |
| CO-5 | Acquiring knowledge of economical aspects of marine. |

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| **SYLLABUS | Elective Paper – III -2 | MARINE BIOTECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | Marine Ecosystems & Its functioning, Ocean currents, Physical & chemical properties of sea water, Ecological divisions of the Sea- Euphotic-Mesopelagic- Bathopelagic- Benthos-Intertidal, Estuarine- Saltmarsh- Mangrove- Coral Reef. | 7 |
| **II** | Marine microbial habitats- Screening for Secondary metabolites from marine microbes (Bacteria, Fungi, Actinomycetes and marine microalgae). Biofouling, Biofilm, Antifouling, Anticorrosion. Probiotic bacteria and their importance in aquaculture.  | 7 |
| **III** | Definitions- Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Sea anemone and Corals)- marine toxins- antiviral and antimicrobial agents. | 7 |
| **IV** | Culture aspect-Seaweed (Kappaphycus alvarezii), Fish chromosome manipulation in aquaculture- Hybridization-Gynogenesis-Androgensis- Polyploidy, Artificial Insemination, Eye stalk ablation- Trangenesis and Cryopreservation. | 7 |
| **V** | Agar- Agarose - Alginate- Carragennan- Chitin- Chitosan- Heparin. | 7 |
| **Reference Books**1. Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp.
2. Milton Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Genetics of Marine Organisms, Science Pub Inc.
3. Y. Le Gal and H.O.Halvorson 1998, New Developments in Marine Biotechnology. Springer.
4. David H. Attaway, 2001. Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.
5. Rita R. Colwell 1984. Biotechnology in the Marine Sciences (Advances in Marine Science & Biotechnology) Wiley Interscience.
6. Scheupr, P.J. (Ed.), 1984. Chemistry of Marine Natural Products, ,Chemical and Biological Perspectives. Vol. I III, Academic Press, New York
7. Marine Biology- Lalli C.M. and T.R. Parsons., 1997. Biological Oceanography - An Introduction, Elsevier, 314 pp
8. Marine Pollution- Clark, R. B. 2001. Marine pollution, Fifth edition. Oxford University press, New York Inc., 231pp
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| **SEMESTER: VI****PART: III** | **ELECTIVE – VII****23UBTHE64-3** **BIOENTREPRENURSHIP** | **CREDIT:3** **HOURS:5** |

**Learning Outcome:**

Student will be able to identify the challenges of being a Bioentrepreneur and understand the current global status of the Bio industry. They will also be able to generate a detailed business plan and identify various funding agencies. They will excel in technical skills such as Vermicomposting, Sericulture, Aquaponics, Mushroom cultivation and SCP Production.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand the knowledge of Basics of Bio entrepreneurship. |
| CO-2 | Learn about the business plan and marketing conditions. |
| CO-3 | Knowledge about the Vermicomposting and cultivation of silkworm |
| CO-4 | Describe about the Cultivation, Medicinal and Nutritional properties of mushroom |
| CO-5 | Understand the single cell protein production from various source of microorganisms |

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| **SYLLABUS | Elective Paper – III - 3 | BIOENTREPRENURSHIP** |
| **Unit** | **Content** | **Hours** |
| **I** | Basics of Bio entrepreneurship -Biotechnology in a Global scale; types of Bio-industries – Biopharma, Bioagri and Bioservice innovations – Successful Entrepreneur – Creativity, Leadership, Managerial skills, Team building, Decision making; Public and private funding agencies (MSME, DBT, BIRAC, Startup & Make in India) | 6 |
| **II** | Business plan preparation; business feasibility analysis by SWOT, business plan proposal for virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices. Market Conditions, Identifying the need of the customers.  | 6 |
| **III** | Vermicomposting –Earth Worms-Ecological types-Vermiculture-Compost pit-Vermi bed-applications - Sericulture-Mulberry cultivation-Silkworm Rearing-Economics of silkworm Production-Chawki Rearing-Sericulture in India. | 6 |
| **IV** | Phases of Mushroom Cultivation; Selection of an acceptable mushroom species/strains, Management of mushroom development, Mushroom harvesting; Mushroom diseases, Medicinal and Nutritional properties of mushroom. Aquaponics- Systems-Fish and Vegetables-Nutrients and Biofilters-Advantages and Disadvantages. | 6 |
| **V** | Single Cell Protein Production: Source: Algae, Bacteria, Yeast – Cultivation of Single Cell protein: SPIRULINA Cultivation – Production site, Microorganism, Experimental design; harvesting and Drying. | 6 |
| **Reference Books*** + - 1. Adams, D. J., & Sparrow, J. C. Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.
			2. Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
			3. Onetti, A., & Zucchella, A. (n.d.). Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Routledge.
			4. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
			5. Desai, V.The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
1. Aquaponics for Beginners, 2018 Nick Brooke Aquaponics Fish: Best Fish Species For Aquaponic Gardening by Timothy trip.
2. An Introduction to sericulture by G.Ganga,J.Sulochana Chetty. Silk: Processing, Properties and Applications Book by K. Murugesh Babu
3. Growing gourmet and medicinal mushrooms by Paul stamets
4. Single Cell Protein Production from Lignocellulosic Biomass by P.Bajpai
5. Neutraceutical spirulina: Commercial cultivation using rural technology in india by Pushpa Srivastava
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| **SEMESTER: VI****PART: III** | **23UBTHE65-1** **ELECTIVE – VIII****FORENSIC BIOTECHNOLOGY** | **CREDIT:3** **HOURS:5** |

**Learning Outcome:**

This course enhances student’s knowledge on demonstrate analytical capabilities and scientific principles required in a Forensic laboratory.

**Course outcomes**:

At the end of the Course, th

e Student will be able to:

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| CO-1 | Understanding the importance of forensic principles and technology |
| CO-2 | Applicability in identifying the candidate who convicted the crime scenery |
| CO-3 | Understand the finding and identifying face image by forensic art illustration |
| CO-4 | Gain added skills in terms tracing the victim death by means of adapting the measurable molecular approaches. |
| CO-5 | Understand the concepts of DNA finger printing technology |

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| **SYLLABUS | Elective Paper – IV -1 | FORENSIC BIOTECHNOLOGY** |
| **Unit** | **Content** | **Hours** |
| **I** | Definition and scope of Forensic Biotechnology, History and development, Forensic genetics, Forensic agriculture. | 6 |
| **II** | Crime scene investigation; collection, preservation, packing and forwarding of physical and trace evidence. Questioned documents – identification of handwriting, signature and detection of forgery. | 6 |
| **III** | Serology - Fresh blood grouping and typing, stains of bloods. Identification of blood stains, collection and storage of allied body fluids (semen, saliva and blood). Case studies. | 6 |
| **IV** | PCR, RFLP, AFLP, Microscopy (Electron, Fluorescent) and Chromatography (Paper, TLC & HPLC) in forensic investigation. | 6 |
| **V** | DNA Profiling, Isolation of DNA from blood samples, DNA testing in cases of disputed paternity and maternity. | 6 |
| **Reference Books**1. Jim Fraser, " Forensic Science: A very short introduction", Oxford university press, 2010.
2. Nageshkumar G Rao, Textbook of Forensic Medicine & Toxicology, Jaypee, 2013.
3. K.S. Narayan reddy and O.P. Murty, The Essentials of Forensic Medicine & Toxicology, 35th Edition, Jaypee, 2017.
4. William Goodwin, Adrian Linacre, SibteHadi, “An introduction to Forensic Genetics”, John Wiley & Sons Ltd 2007.
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| **SEMESTER: VI****PART: III** | **ELECTIVE – VIII** **23UBTHE65-2** **GOOD LABORATORY PRACTICES (GLP)** | **CREDIT:3** **HOURS:5** |

**Learning Outcome:**

This course enhances student’s knowledge on essential practices that need to be followed in a laboratory or industry, awareness on safety measures and Industry standards.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand the labs associated with Biotechnology and hazards |
| CO-2 | Gain knowledge about the documentation and concentration calculation  |
| CO-3 | Acquires knowledge on principles of maintenance of laboratory with instruments. |
| CO-4 | Understand the Standard Operating Procedures and its importance |
| CO-5 | Demonstrate the waste and its treatment in laboratory |

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| **SYLLABUS | Elective Paper – IV -2 | GOOD LABORATORY PRACTICES (GLP)** |
| **Unit** | **Content** | **Hours** |
| **I** | Types of labs associated with Biotechnology (General lab, microbial culture lab, plant tissue culture lab, Fermentation lab, computational stimulation lab), Types of Chemical (Analytical grade, molecular grade) and its various arrangement (Arrangement of basic chemicals, solvent, acid and base, fine chemicals like dyes, protein and enzyme storage units), Physical chemical characteristics: hygroscopic, corrosive, volatile properties; Fire and explosion hazard data, Health hazards (how to use UV-illuminator), Fumigation technique. | 6 |
| **II** | Methods and types of documentation (pre-lab writes, result recording and post lab report: interpretation of result), Dilution factor calculation, Molarity, percentage, dilution of concentrated solution, metric units (kg to gms and vice -versa). | 6 |
| **III** | Principles, use and maintenance of laboratory instruments like Autoclave, hot air oven, Incubators, Water bath, Refrigerator, Centrifuge, Calorimeter, pH meter, Haemocytometer, Microtomes, Electronic balances, Biosafety cabinets. SOP preparation for instrumentation | 6 |
| **IV** | Good Laboratory guidelines, Elements of GLP, Standard Operating Procedures and its importance, Quality Assurance & Quality control, Internal audit basics, ISO, BIS and HACCP standards | 6 |
| **V** | Definition of waste, types of waste: Biological and chemical waste, methods of Safe Disposal of biological and chemical waste: treatment methods of Ethidium Bromide solutions, Electrophoresis Gels, Contaminated Gloves, debris, Wastes containing sodium azide, Silver staining solutions, Perchloric acid, Nanoparticle wastes, Spill management, Awareness and training for personnel. | 6 |
| **Reference Books**1. Milton A. Anderson GLP Essentials: A Concise Guide to Good Laboratory Practice, Second Edition 2nd Edition, Published by CRC press.
2. WHO training manual on Good Laboratory Practices, 2nd Edition.
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| **SEMESTER: VI****PART: III** | **ELECTIVE – VIII****23UBTHE65-3** **BIOPROSPECTING** | **CREDIT:3** **HOURS:5** |

**Learning Outcome:**

The paper provides adequate knowledge in primary and secondary screening methods in drug designs. In the course objectives are framed to give an adequate knowledge about fermentation process and types of fermentation process.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Gain knowledge of bioreactor. |
| CO-2 | Understand the application and functioning of bioreactors. |
| CO-3 | Understand the fermentation process growth of cultures in the fermentor. |
| CO-4 | Understand the downstream procedure and fermenter waste treatment. |
| CO-5 | Knowledge the role of fungi in food and feed industries viz. Edible mushrooms, different cultivation and nutritional aspects of mushrooms. |

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| **SYLLABUS | Elective Paper – IV -3 | BIOPROSPECTING** |
| **Unit** | **Content** | **Hours** |
| **I** | Bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases. | 6 |
| **II** | Oxygen transfer, critical oxygen concentration, determination of Kla, heat transfer, aeration/agitation and its importance. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors. | 6 |
| **III** | Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process form shake flask to industrial fermentation. | 6 |
| **IV** | Downstream Processing Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization. | 7 |
| **V** | Chemically creative fungi; screening for industrially useful fungal metabolites; drugs and pharmaceuticals from fungi; Ecotaxonomic approach in chemical screening; primary and secondary products of metabolism; classification of secondary metabolites; primary and secondary screening of antibiotic producers; enrichment culture, techniques for strain improvement and Strain development; Industrial fungal strains preliminary and high throughput screening (HST); leads and lead optimization, IPR issues and patents. | 7 |
| **Reference Book**1. McDuffie, N. G. (2013). Bioreactor design fundamentals. USA: Butterworth- Heinemann.
2. Tapobrata, P. (2011). Bioreactors analysis and design. (1st ed.). New York: McGraw Hill Education
3. Carl-Fredrik, M. (2016). Bioreactors design, operation and novel applications. (1st ed.). New Jersey: Wiley-VCH.
4. Anuj, K. R. (2012). Downstream processing techniques in biotechnology: Purification Techniques of Biological Compounds. New Delhi: Global Vision Publishing House.
5. Jane, K. (2015). Reverse osmosis design, processes and applications. (2nd ed.). Beverly, MA: Scrivener Publishing LLC.
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| **SEMESTER: VI****PART: IV** | **23UBTHF66** **Professional Competency Skill** **MOLECULAR DIAGNOSTICS** | **CREDIT:2** **HOURS:2** |

**Learning Outcome:**

The paper provides adequate knowledge to learn the significance and history of molecular diagnostics. In the course objectives are framed to give different immunodiagnostic methods and their specific applications.

**Course outcomes**:

At the end of the Course, the Student will be able to:

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| CO-1 | Understand the basic concepts of molecular diagnostics. |
| CO-2 | Learn the traditional methods of disease diagnosis. |
| CO-3 | Understand about the molecular methods of disease diagnosis. |
| CO-4 | Understand the applications of molecular diagnostic procedures. |
| CO-5 | Knowledge the Diagnose and interpret different diseases using assays. |

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| **SYLLABUS | Skill Paper – 1 | MOLECULAR DIAGNOSTICS** |
| **Unit** | **Content** | **Hours** |
| **I** | Introduction and History of diagnostics of diseases, mode of infection, types of infectious diseases, philosophy, and general approach to clinical specimens. | 6 |
| **II** | Diagnosis of infectious diseases caused by bacteria, fungi, viruses, protozoa, and Helminthes. Detection and quantification of biochemical parameters. | 6 |
| **III** | Disease identification and Genetic tests of disorders; Population screening for genetic disorders; Treatment and management of genetic disorders. | 6 |
| **IV** | PCR-based microbial typing; Culture-independent analysis of bacteria; Molecular diagnosis of fungal pathogens; RAPD for animals and plants. | 5 |
| **V** | Types [RIA, ELISA, Chemiluminescent IA, FIA] and specific applications; Immunohistochemistry – principle, and techniques. Different Levels of Biosafety, Containment. | 6 |
| **Reference Book**1. Bruce Alberts. Molecular biology of the cell. 6th Edition.
2. Darnell J, Lodish H, and Baltimore D. Molecular Cell Biology.
3. De Robertis EDP and De Robertis EMF. Cell and Molecular Biology.
4. Ralph Michael Aloisi, Lippincott Williams, and Wilkins. Principles of Immunology and Immunodiagnostics.
5. Valones et al., Braz. J. Microbiol., (2009). Principles and applications of polymerase chain reaction in medical diagnostic fields: a review 40, 1–11.
6. Daniel. C.L., “Introduction to Proteomics”, Humana Press. 2002
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| **SEMESTER: VI****PART: V** | **23UBTHX67** **EXTENSION ACTIVITY** | **CREDIT:1** **HOURS:-** |

**(Refer to the Regulations)**