# University of Kerala

University of Kerala - Four Year Under Graduate Programme (UOK-FYUGP)

Syllabus for
Bachelor of Science in
**BIOTECHNOLOGY**

**2024 April**

# Aim and objective

The Four Year Degree Programme (FYUGP) in **b**iotechnology as one of the core subjects is designed to develop a scientific temperament to find out technological interface in modern areas of biotechnology to achieve its goal at applied level. It will help the students to become critical and curious in their outlook about modern Biotechnology. The courses are designed to impart the essential basics in biotechnology as well as its advanced fields.

The various courses in the programme is aimed to develop proficiency in the theory as well as practical experiments to achieve the goal of this course in applied as well as research level. The course structure will encompass usage of common equipments, laboratory experiments, individual or group projects along with case study reports and preparation of research proposals at advanced level to exploit the cognitive level of students at its maximum heights. The students will be equipped with knowledge in the modern areas of biotechnology and its application in medical science, agriculture, industry, proteomics, genomics, bioinformatics, nanobiotechnology etc. Apart from understanding biotechnology and its potential in developing the nation, it will create awareness about the socio, ethical and environmental aspects of the course also. This will help in eliminating public fear about the contribution of biotechnology and confusion of this subject at applied levels. Students, who pursue thisprogramme pass out successfully, will surely have an urge to continue higher studies in biotechnologyand potential to explore industrial areas to achieve significantly in their career development.

## Graduate Attributes

Graduate attributes bridge the gap between academia and the real world, fostering lifelong learning and meaningful contributions. They denote the skills, competencies and high-level qualities that a student should acquire during their university education. Apart from gathering content knowledge, these attributes go beyond the assimilation of information to its application in various contexts throughout a graduate's life. It aims in inculcating the art of critical thinking, problem solving, professionalism, leadership readiness, teamwork, communication skills and intellectual breadth of knowledge. The University of Kerala envisages to pave the path in guiding the student's journey to shape these attributes uniquely, making them integral to personal growth and success in various spheres of life. The University strives to ensure that these graduate attributes are not just checkboxes, but they play a pivotal role in shaping the students into capable, compassionate and responsible individuals with a high degree of social responsibility.

## Programme Outcomes (PO)

| No. | Programme Outcomes (POs) |
|---|---|
| **PO-1** | **Critical thinking**<br>o analyze information objectively and make a reasoned judgment<br>o draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions<br>o identify logical flaws in the arguments of others<br>o evaluate data, facts, observable phenomena, and research findings to draw valid and relevant results that are domain-specific |
| **PO-2** | **Complex problem-solving**<br>o solve different kinds of problems in familiar and no-familiar contexts and apply the learning to real-life situations<br>o analyze a problem, generate and implement a solution and to assess the success of the plan<br>o understand how the solution will affect both the people involved and the surrounding environment |
| **PO-3** | **Creativity**<br>o produce or develop original work, theories and techniques<br>o think in multiple ways for making connections between seemingly unrelated concepts or phenomena<br>o add a unique perspective or improve existing ideas or solutions<br>o generate, develop and express original ideas that are useful or have values |
| **PO-4** | **Communication skills**<br>o convey or share ideas or feelings effectively<br>o use words in delivering the intended message with utmost clarity<br>o engage the audience effectively<br>o be a good listener who are able to understand, respond and empathize with the speaker<br>o confidently share views and express himself/herself |
| **PO-5** | **Leadership qualities**<br>o work effectively and lead respectfully with diverse teams<br>o build a team working towards a common goal<br>o motivate a group of people and make them achieve the best possible solution.<br>o help and support others in their difficult times to tide over the adverse situations with courage |

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|---|---|
| **PO-6** | **Learning 'how to learn' skills**<br>o acquire new knowledge and skills, including 'learning how to learn skills, that are necessary for pursuing learning activities throughout life, through self-paced and self-directed learning<br>o work independently, identify appropriate resources required for further learning<br>o acquire organizational skills and time management to set self-defined goals and targets with timelines<br>o inculcate a healthy attitude to be a lifelong learner |
| **PO-7** | **Digital and technological skills**<br>o use ICT in a variety of learning and work situations, access, evaluate, and use a variety of relevant information sources<br>o use appropriate software for analysis of data<br>o understand the pitfalls in the digital world and keep safe from them |
| PO-8 | **Value inculcation**<br>o embrace and practice constitutional, humanistic, ethical, and moral values in life including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values<br>o formulate a position/argument about an ethical issue from multiple perspectives<br>o identify ethical issues related to work, and follow ethical practices, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights<br>o adopt an objective, unbiased, and truthful actions in all aspects of work |

**Program Specific Outcomes (PSO)**

After successfully completing the course students will be able to:-

**<u>Programme Specific Outcomes (PSO)</u>**

Upon completion of the programme the graduate will be able to

| No. | PO | PO No. |
|---|---|---|
| PSO-1 | Develop basic understanding of the various streams of biotechnology. Apply the knowledge in the modern areas of biotechnology such as medical science, environment, agriculture, industry, proteomics, genomics, computational biology, bioinformatics, nanobiotechnology etc. | |
| PSO-2 | Understand biotechnology and its power to develop scientific temperament, ethical and social responsibilities in students. | |
| PSO-3 | As biotechnology is an interdisciplinary course students acquire technological skilfulness by connecting disciplinary and interdisciplinary aspects of Biotechnology. Student project helps in creating analytical thinking and interpreting the inference. Enhance practical skills and competency in students to conduct experiments in Biotechnology | |
| PSO4 | Pursue higher studies in Biotechnology and contribute significantly in its development. Inculcate skill to organize scientific events and effective communication. Ascertain their area of interest in research | |
| PSO5 | Be able to address challenges in industrial and research areas with socio-ethical responsibilities. Inculcate entrepreneurial skills to explore possibilities in Biotechnology with social outlook | |

The University of Kerala FYUGP has a student centric approach in which the student can choose their pathway for learning. On successful attainment of minimum credits of 133 in a three year period, a student shall be awarded an Undergraduate Degree. Ina four year period , the student can successfully attain 177 credits and shall be awarded with either Undergarduate Honours Degree or Undergraduate Honours with Research Degree. The student can acquire credits through the following categories of courses.

1. **Discipline Specific Core courses(DSC)**
2. **Discipline Specific Elective Courses)DSE)**
3. **General Foundation Courses**
   **1.Multidisciplinary courses(MDC)**
   **Ability Enhancement course (AEC)**
   **Value addition course(VAC)**
   **Skill enhancement courses(SEC)**

DSC courses are the core credit courses in a particular discipline. Student may choose DSC courses as their major or Minor course of study

Credit means the value assigned to a course which indicate the level of instruction. One hour lecturer per week equals 1 credit, 2 hours practical class per week equals 1 credit

Students who secure at least 75% of marks in all six semesters can choose Under graduate Honours with Research stream in the fourth year.

It is mandatory for all the students who enrol for a four year UG programme to acquire 39 credit from 13 general foundation courses. It should be completed within first three years of FYUGP.

The various courses and its corresponding credits are depicted in the following table.

**Summary of courses**

| SI No | Subject Specific Coded | study components | credits/ course | Theory hours/tutorial week | Mode of Study | Practical | |
|---|---|---|---|---|---|---|---|
| | | | | | | Essential experiments/ week | Individual/Group work /week |
| ***SEMESTER I*** | | | | | | | |
| **Discipline Specific Core 100-199 Level-A1(P)** | | | | | | | |
| 1 | UK1DSCBIT100 | **Essentials of Biotechnology** | 4 | 3 | Offline | 1 | 1 |
| 2 | UK1DSCBIT101 | Environmental Studies | 4 | 3 | Offline | 1 | 1 |
| 3 | UK1DSCBIT102 | IT for Biological science | 4 | 3 | Offline | 1 | 1 |
| 4 | UK1DSCBIT103 | Fundamentals of Biotechnology | 4 | 3 | Offline | 1 | 1 |
| 5 | UK1DSCBIT104 | Food and nutrition | 4 | 3 | Offline | 1 | 1 |
| 6 | UK1DSCBIT105 | Chemistry for life sciences-I | 4 | 3 | offline | 1 | 1 |
| **Multidisciplinary Courses 100-199** | | | | | | | |
| 1 | UK1MDCBIT100 | Emerging pandemics & infectious diseases | 3 | 3 | Offline | - | - |
| 2 | UK1MDCBIT101 | Innovations in Biotechnology | 3 | 3 | Offline | - | - |
| 3 | UK1MDCBIT102 | Nutrition and Health | 3 | 3 | Offline | - | - |
| ***SEMESTER 2-A2(P)*** | | | | | | | |
| **Discipline Specific Core 100-199 Level** | | | | | | | |
| 1 | UK2DSCBIT106 | **Biomolecules** | 4 | 3 | Offline | 1 | 1 |
| 2 | UK2DSCBIT107 | Elements of biology | 4 | 3 | Offline | 1 | 1 |
| 3 | UK2DSCBIT108 | Chemistry for life sciences-II | 4 | 3 | Offline | 1 | 1 |
| 4 | UK2DSCBIT109 | Fundamentals of Microbiology | 4 | 3 | Offline | 1 | 1 |
| 5 | UK2DSCBIT110 | Basics of Cell biology | 4 | 3 | Offline | 1 | 1 |
| 6 | UK2DSCBIT111 | Environmental microbiology, biodiversity and conservation | 4 | 3 | Offline | 1 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | UK2DSCBIT112 | Biomathematics | 4 | 4 | Online-NPTEL | | |
| **Multidisciplinary Courses 100-199** | | | | | | | |
| 1 | UK2MDCBIT103 | Biofuel technology | 3 | 3 | Offline | - | - |
| 2 | UK2MDCBIT104 | Food safety, preservation and quality management | 3 | 3 | Offline | - | - |
| 3 | UK2MDCBIT105 | Life style disease and management | 3 | 3 | Offline | - | - |
| ***SEMESTER 3*** | | | | | | | |
| **Discipline Specific Core 200-299 Level A3(P)** | | | | | | | |
| 1 | UK3DSCBIT200 | Biomolecules and metabolism | 4 | 3 | Offline | 1 | 1 |
| 2 | UK3DSCBIT201 | **Microbiology** | 4 | 3 | Offline | 1 | 1 |
| 3 | UK3DSCBIT202 | Basics of Enzymology | 4 | 3 | Offline | 1 | 1 |
| 4 | UK3DSCBIT203 | Microbial Metabolism | 4 | 3 | Offline | 1 | 1 |
| 5 | UK3DSCBIT204 | plant physiology | 4 | 3 | Offline | 1 | 1 |
| 6 | UK3DSCBIT205 | Animal Physiology | 4 | 3 | Offline | 1 | 1 |
| **Discipline Specific Elective courses 200-299 DSE-1** | | | | | | | |
| 1 | UK3DSEBIT200 | **Biophysics and instrumentation** | 4 | 4 | Offline | - | - |
| 2 | UK3DSEBIT201 | Enzyme engineering | 4 | 4 | offline | | |
| 3 | UK3DSEBIT202 | Introduction to marine Biotechnology | 4 | 4 | Offline | | |
| 4 | UK3DSEBIT203 | Biomolecular interactions and cell signalling | 4 | 4 | offline | | |
| **Value Added Courses 200-299** | | | | | | | |
| 1 | UK3VACBIT200 | IPR,Bioethics and Biosafety | 3 | 3 | Offline | - | - |
| ***SEMESTER 4*** | | | | | | | |
| **Discipline Specific Core 200-299 Level A4(P),A5(P)** | | | | | | | |
| 1 | UK4DSCBIT206 | **Cell biology & Genetics** | 4 | 3 | Offline | 1 | 1 |
| 2 | UK4DSCBIT207 | **Molecular Biology** | 4 | 3 | Offline | 1 | 1 |
| 3 | UK4DSCBIT208 | Developmental Biology | 4 | 3 | Offline | 1 | 1 |
| 4 | UK4DSCBIT209 | Metabolism and Energetics | 4 | 3 | Offline | 1 | 1 |
| **Discipline Specific Elective courses 200-299, DSE2** | | | | | | | |
| 1 | UK4DSEBIT204 | Bioinformatics | 4 | 3 | Offline | 1 | 1 |
| 2 | UK4DSEBIT205 | Microbial Metabolism | 4 | 3 | Offline | 1 | 1 |
| **Value Added Courses 200-299** | | | | | | | |
| 1 | UK4VACBIT201 | Good Laboratory Practices and Quality | 3 | 3 | Offline | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Control in Biotechnology | | | | | |
| 2 | UK4VACBIT202 | Environmental Monitoring and Assessment | 3 | 3 | Offline | - | - |
| **Skill Enhancement Courses 200-299** | | | | | | | |
| 1 | UK4SECBIT200 | **B**ioassessment and Biomonitoring | 3 | 3 | Offline | - | - |
| 2 | UK4SECBIT201 | Basics of phytochemistry and medicinal plant-based industry | 3 | 3 | Offline | - | - |
| **UK4INTBIT200 Summer Inernship -3 credit** | | | | | | | |
| ***SEMESTER 5*** | | | | | | | |
| **Discipline Specific Core Level 300-399- A6(P),A7,A8** | | | | | | | |
| 1 | UK5DSCBIT300 | Recombinant DNA technology | 4 | 3 | Offline | 1 | 1 |
| 2 | UK5DSCBIT301 | Food and Industrial Biotechnology | 4 | 4 | Offline | - | - |
| 3 | UK5DSCBIT302 | Immunology | 4 | 4 | Offline | - | - |
| | UK5DSCBIT303 | Ethnobotany and medicinal botany | 4 | 3 | Offline | 1 | 1 |
| **Discipline Specific Elective courses 300-399, DSE3(P), DSE4** | | | | | | | |
| 1 | UK5DSEBIT300 | Genomics and proteomics | 4 | 4 | offline | | - |
| 2 | UK5DSEBIT301 | Molecular diagnostics | 4 | 3 | Offline | 1 | 1 |
| 3 | UK5DSEBIT302 | Nanobiotechnology | 4 | 3 | Offline | 1 | 1 |
| 4 | UK5DSEBIT303 | Cancer biology | 4 | 3 | Offline | 1 | 1 |
| 5 | UK5DSEBIT304 | Microbial metabolism | 4 | 3 | Offline | 1 | 1 |
| 6 | UK5DSEBIT305 | General virology | 4 | 3 | Offline | 1 | 1 |
| 7 | UK5DSEBIT306 | Food microbiology | 4 | 3 | Offline | 1 | 1 |
| 8 | UK5DSEBIT307 | Marine biotechnology | 4 | 3 | Offline | 1 | 1 |
| 9 | UK5DSEBIT308 | Agriculture biotechnology | 4 | 3 | Offline | 1 | 1 |
| 10 | UK5DSEBIT309 | Microbial diversity and phytopathology | 4 | 3 | Offline | 1 | 1 |
| 11 | UK5DSEBIT310 | Pharmaceutica lbiotechnology - - | 4 | 3 | Offline | 1 | 1 |
| **Skill enhancement Courses 300-399** | | | | | | | |
| 1 | UK5SECBIT300 | Plant Tissue Culture Entrepreneurship | 3 | 3 | Offline | - | - |
| 2 | UK5SECBIT301 | Entrepreneurship in Biotechnology | 3 | 3 | Offline | - | - |
| ***SEMESTER 6*** | | | | | | | |

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|---|---|---|---|---|---|---|---|
| **Discipline Specific Core Level 300-399- A9(P),A10,A11** | | | | | | | |
| 1 | UK6DSCBIT304 | Animal Biotechnology | 4 | 4 | Offline | - | - |
| 2 | UK6DSCBIT305 | Plant Biotechnology | 4 | 3 | Offline | 1 | 1 |
| 3 | UK6DSCBIT306 | Environmental Biotechnology | 4 | 4 | Offline | - | - |
| **Discipline Specific Elective courses 300-399, DSE5(P), DSE6** | | | | | | | |
| 1 | UK6DSEBIT311 | Industrial Regulatory Affairs | 4 | 3 | Offline | 1 | 1 |
| 2 | UK6DSEBIT312 | Food safety, Preservation and Quality management | 4 | 3 | Offline | 1 | 1 |
| 3 | UK6DSEBIT313 | Microbiome Studies | 4 | 3 | Offline | 1 | 1 |
| 4 | UK6DSEBIT314 | Microbial metabolites | 4 | 4 | Offline | - | - |
| 5 | UK6DSEBIT315 | Cancer therapeutics | 4 | 4 | Offline | - | - |
| 6 | UK6DSEBIT316 | Tumour immunotherapy | 4 | 3 | Offline | 1 | 1 |
| 7 | UK6DSEBIT317 | Pharmacogenomics and Pharmacovigilence | 4 | 4 | Offline | - | - |
| 8 | UK6DSEBIT318 | Pharmabiologics | 4 | 3 | Offline | 1 | 1 |
| 9 | UK6DSEBIT319 | Marine biodiversity | 4 | 4 | offline | - | - |
| 10 | UK6DSEBIT320 | Marine natural products | 4 | 4 | offline | - | - |
| 11 | UK6DSEBIT321 | Marine bioremediation | 4 | 3 | Offline | 1 | 1 |
| 12 | UK6DSEBIT322 | Vaccine technology | 4 | 4 | offline | - | - |
| 13 | UK6DSEBIT323 | Advanced studies in antivirals | 4 | 3 | Offline | 1 | 1 |
| 14 | UK6DSEBIT324 | Advanced food preservation technology | 4 | 4 | offline | - | - |
| 15 | UK6DSEBIT325 | Functional foods, Neutraceuticals and Neutrigenomics | 4 | 4 | Offline | - | - |
| 16 | UK6DSEBIT326 | Datascience and biotechnology | 4 | 4 | Online | - | - |
| 17 | UK6DSEBIT327 | Clinical research and data management | 4 | 3 | Offline | 1 | 1 |
| 18 | UK6DSEBIT328 | Introduction to Forensic biotechnology | 4 | 3 | Offline | 1 | 1 |
| 19 | UK6DSEBIT329 | Chemical ecology | 4 | 3 | Offline | 1 | 1 |
| **Skill enhancement Courses 300-399** | | | | | | | |
| 1 | UK6SECBIT302 | Datascience and biotechnology | 3 | 3 | Offline | -- | - |

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|---|---|---|---|---|---|---|---|
| 2 | UK6SECBIT303 | Clinical research and data management | 3 | 3 | Offline | - | - |
| 3 | UK6SECBIT304 | Biopolymer Technology | 3 | 3 | Offline | - | - |
| 4 | UK6SECBIT305 | Python programming | 3 | 3 | Online NPTEL | - | - |
| 5 | UK7SECBIT306 | Industrial Regulatory Affairs | 3 | 3 | Offline | - | - |
| ***SEMESTER 7*** | | | | | | | |
| **Discipline Specific Core Level 400-499- A12(P),A13(P) capstone** | | | | | | | |
| 1 | UK7DSCBIT400 | stem cell technology and regenerative medicine | 4 | 3 | Offline | 1 | 1 |
| 2 | UK7DSCBIT401 | Introduction to metabolic engineering | 4 | 3 | Offline | 1 | 1 |
| 3 | UK7DSCBIT402 | Gene Therapy and gene editing Technolgies | 4 | 3 | Offline | 1 | 1 |
| **Discipline Specific Elective courses 400-499, DSE7** | | | | | | | |
| 1 | UK7DSEBIT400 | Research methodology and Biostatistics | 4 | 4 | offline | - | - |
| ***SEMESTER 8*** | | | | | | | |
| MOOC Courses A-14, A-15 | | | | | | | |
| 1 | UK8DSCBIT403 | | | | online | | |
| 2 | UK8DSCBIT404 | | | | online | | |
| ***Project*** | | | | | | | |
| 1 | UK8CIPBIT400 | Internship Project for UG Honours | | | | | |
| 2 | UK8RPHBIT400 | Research Project for UG Honours with Research | | | | | |
| ***SPECIALIZATIONS IN BIOTECHNOLGY*** | | | | | | | |
| | **PharmaBiologics** | | | | | | |
| | UK5DSEBIT301 | Genomics and proteomics | 4 | 3 | 1 | - | - |
| | UK5DSEBIT310 | Pharmaceutical biotechnology | 4 | 2 | 1 | 1 | 1 |
| | UK6DSEBIT328 | pharmacogenomics and pharmacovigilence | 4 | 3 | 1 | - | - |
| | UK6DSEBIT318 | PharmaBiologics | 4 | 2 | 1 | 1 | 1 |
| | **Clinical research and data management** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | UK4DSEBIT204 | Bioinformatics | 4 | 3 | 1 | 1 | 1 |
| | UK5DSEBIT301 | Genomics and proteomics | 4 | 3 | 1 | - | - |
| | UK6SECBIT302 | Datascience and biotechnology | 4 | 3 | 2 | - | - |
| | UK6DSEBIT327 | Clinical research and data management | 4 | 2 | 1 | 1 | 1 |
| | **Marine Bioproducts** | | | | | | |
| | UK4DSEBIT204 | Biophysics and instrumentation | 4 | 3 | 1 | - | - |
| | UK5DSEBIT307 | Marine biotechnology | 4 | 2 | 1 | 1 | 1 |
| | UK6DSEBIT319 | Marine Biodiversity | 4 | 3 | 1 | - | - |
| | UK6DSEBIT320 | Marine Bioproducts | 4 | 2 | 1 | 1 | 1 |
| | **Cancer Therapeutics** | | | | | | |
| | UK5DSEBIT300 | Genomics and proteomics | 4 | 3 | 1 | - | - |
| | UK5DSEBIT303 | Cancer biology | 4 | 2 | 1 | 1 | 1 |
| | UK6DSEBIT315 | Cancer Therapeutics | 4 | 3 | 1 | - | - |
| | UK6DSEBIT316 | Tumour Immunotherapy | 4 | 3 | 1 | - | - |
| | **Molecular diagnostics and Therapeutics** | | | | | | |
| | UK5DSEBIT301 | Genomics and proteomics | 4 | 3 | 1 | - | - |
| | UK5DSEBIT300 | Molecular diagnostics | 4 | 3 | 1 | - | - |
| | UK6DSEBIT315 | Cancer Therapeutics | 4 | 2 | 1 | 1 | 1 |
| | UK6DSEBIT322 | Vaccine Technology | 4 | 3 | 1 | - | - |
| | UK6DSEBIT323 | Advanced Studies in Antivirals | 4 | 2 | 1 | 1 | 1 |
| | **Functional foods, neutraceuticals and neutrigenomics** | | | | | | |
| | UK5DSEBIT301 | Genomics and proteomics | 4 | 3 | 1 | - | - |
| | UK5DSEBIT306 | Food microbiology | 4 | 2 | 1 | 1 | 1 |
| | UK6DSEBIT324 | Advanced food preservation technology | 4 | 2 | 1 | 1 | 1 |
| | UK6DSEBIT312 | Food safety, Preservation and Quality management | 4 | 2 | 1 | 1 | 1 |
| | UK6DSEBIT325 | Functional foods, neutraceuticals and neutrigenomics | 4 | 3 | 1 | - | - |

# SEMESTER I

# Discipline Specific Core 100-199 Level-A1(P)

**University of Kerala**

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK1DSCBIT100 | | | | |
| Course Title | ESSENTIALS OF BIOTECHNOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | I | | | | |
| Academic Level | 100 - 199 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 hours | 1 | 2 hours | 5 |

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|---|---|
| Pre-requisites | Basic knowledge in life sciences |
| Course Summary | This course provides a summary of the essential concepts, methodologies, applications, and implications of biotechnology. Students will comprehend the fundamental principles underlying various domains like plant, animal, environmental, food, and industrial biotechnology and their significance in advancing scientific understanding, technological innovation, and societal progress. |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | **Overview of Biotechnology** | **5** |
| | 1 | Historical perspectives and Milestones, Scope and significance of Biotechnology, Major Areas of Biotechnology (Red, White, Green and Blue Biotechnology), | |
| | 2 | Commercial potential of Biotechnology, Biotechnology in India, and its global trends | |
| | 3 | Major Biotechnology institutes and companies in India.GenenTech , Bocon case study | |
| **II** | | **Gene & Genetic Engineering** | **9** |
| | 4 | DNA as genetic material, Central dogma, Concept of Gene | |
| | 5 | Genetic Engineering: Definition, Steps involved, A brief account on Tools - Restriction Enzymes, DNA Ligases, Plasmid as vectors (pBR 322).prediction of biological phenomena-Alfa fold2 case study | |
| **III** | | **Plant, Animal and Environmental Biotechnology** | **12** |
| | 6 | Transgenic Plants – Agricultural Applications -Herbicide tolerant crops<br>(Glyphosate resistant), Insect resistant crops (Bt cotton), Nutritionally improved crops (Golden Rice), Shelf-life improved crop (Flavr Savr) and Non-agricultural Applications - Bio-Pharming | |
| | 7 | Transgenic Animals - Applications - Production of therapeutic proteins (ATryn Cow), Environment friendly Farm animals (Enviro pigs), Production of silk (Spider goat) | |
| | 8 | Bioremediation - Bacteria for oil spill clean-up, Heavy metal remediation<br>Bioenergy Production -Biogas, Bioethanol, Biodiesel<br>Bioplastics – PHB and its applications | |
| | 9 | Overview – synthetic genome,Biomimetics,Artificial Life,Unconventional Molecular Biology | |
| | 10 | Brief- Insilico Biology, SciFi Foods,Cellular agriculture, Artificial Intelligence in Biotechnology,Space exploration biology | |
| **IV** | | **Food and Industrial Biotechnology** | **10** |

| | | | |
|---|---|---|---|
| | 11 | Microbial Fermentation in Food Production: Fermented Foods (Yogurt, Cheese) and Beverages (Beer, Wine), SCP- | |
| | 12 | Microbial production of Antibiotics (Penicillin), Vitamins (B12), Amino acids (Glutamic acid), Organic acids (Citric acid), Enzymes (Protease and Amylase), Applications of Hybridoma technology | |
| **V** | **Ethical issues in Biotechnology** | | **9** |
| | 13 | Ethical considerations in biotechnological research and applications, Public perception and acceptance of Biotechnology, Regulatory frameworks, and implications, Dark Biotechnology | |

**Practicum (30 Hours)-[Essential Experiments(15 Hrs), Group/Individual Experiments (15 Hrs) ]**

**Essential Experiments**

1) Awareness on safety Precautions and Good Laboratory Practices
2)Introducing Laboratory Instruments: Microscope, pH meter, Colorimeter, Centrifuge, Incubator, Shaker and Stirrer, Autoclave, Water Bath, LAF, Gel Electrophoresis Systems
3) Preparation of agarose gel for gel electrophoresis.
4) Set up small-scale fermentation experiments using yeast cultures and appropriate growth media.
5) Produce fermented food products such as yogurt using starter cultures

**Suggested Readings:**


1. Introduction to Genetic Engineering & Biotechnology (2008), Nair, A.J., Infinity Science Press.
2. Biotechnology Expanding Horizons (5th edn. 2023), B.D. Singh, MedTech Science Pres
3. Principles of gene manipulation (6th edn.), S.B. Primrose, R.M. Twyman & R.W. Old, Blackwell pub.
4. Gene Cloning & DNA Analysis: An introduction (8th edn), T.A. Brown, Wiley Blackwell pub
5. Advanced Biotechnology (2014), R.C. Dubey, S. Chand Publication
6. Plant Biotechnology: The genetic manipulation of plants (2nd edn), Adrian Slater, Nigel Scott & Mark Fowler, Oxford pub.
7. Biotechnology (2005), U. Satyanarayana & U. Chakrapani, Books & Allied Pub Pvt.Ltd
8. Introduction to Biotechnology & Genetic engineering (2010), Nair, AJ, Johns & Bartlett Pub, Boston USA.
9. Industrial Microbiology (2nd edn.), L.E.J.R. Casida, New Age International P.
10. X) Principles and techniques of Biochemistry & Molecular Biology (7th edn.) edited by Keith Wilson & John Walker, Cambridge University Press.


## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|

| | | | |
|---|---|---|---|
| CO-1 | Understand the history and scope of biotechnology and differentiate among the classes of biotechnology | U | PSO-1,2 |
| CO-2 | Describe the various tools, techniques used in genetic engineering and understand the molecular basis of life | R, U | PSO-1,4 |
| CO-3 | Understand the applications of biotechnology in environment, and associate with applications of transgenic plants and animals | U, E | PSO-1,2,3 |
| CO-4 | Identify the various tools and techniques used for basic biotechnological studies and applications | U, Ap | PSO-3,5 |
| CO-5 | Compare and contrast the various bioprocess technologies in manufacturing of industrial products and understands ethical implications of biotechnology | U | PSO-1,5 |

*R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create*

*Note: 1 or 2 COs/module*

**Name of the Course: Essentials of Biotechnology**
**Credits: 2:1:2 (Lecture: Tutorial: Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L) /Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| 1 | Understand the history and scope of biotechnology and differentiate among the classes of biotechnology | PO-1 PSO-1,2 | U | F | L | |
| 2 | Describe the various tools, techniques used in genetic engineering and understand the molecular basis of life | PO-3 PSO-1,4 | R, U | F, C | T | |
| 3 | Understand the applications of biotechnology in environment, and associate with applications of transgenic plants and animals | PO-1,2 PSO-1,2,3 | U, E | F, C | L | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Identify the various tools and techniques used for basic biotechnological studies and applications | PO-6 PSO-3,5 | U, Ap | F, P | | P |
| 5 | Compare and contrast the various bioprocess technologies in manufacturing of industrial products and understands ethical implications of biotechnology | PO-3,8 PSO-1,5 | U | F | L | |

*F-Factual, C- Conceptual, P-Procedural, M-Metacognitive*

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | - | - | - | 3 | - | - | - | - | - | - | - |
| CO 2 | 2 | - | - | 1 | - | - | - | 2 | - | - | - | - | - |
| CO 3 | 2 | 3 | 1 | - | - | 2 | 1 | - | - | - | - | - | - |
| CO 4 | - | - | 1 | - | 5 | - | - | - | - | - | 2 | - | - |
| CO 5 | 1 | - | - | - | 3 | 2 | - | 1 | - | - | - | - | 2 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |

| | |
|---|---|
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |

# Multidisciplinary Courses 100-199

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK1MDCBIT101 | | | | |
| Course Title | INNOVATIONS IN BIOTECHNOLOGY | | | | |
| Type of Course | MDC | | | | |
| Semester | I | | | | |
| Academic Level | 100 – 199 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 3 | 2 hours | 1 | - | 3 |
| Pre-requisites | Essentials of Biotechnology, Basic Molecular Biology | | | | |
| Course Summary | Bio innovation refers to the application of innovative techniques , technologies and principles to biological systems with the aim of solving challenges in the fields such as Healthcare, Agriculture, Environmental sustainability etc. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Introduction and Concepts** | **9** |
| | 1 | Introduction: Basics and importance of Bio Innovations, | |
| | 2 | Innovative concepts in research and development | |
| | 3 | Major industries in Biotechnology. | |
| II | | **Major areas of Innovations I** | **9** |
| | 4 | Innovations in Genetic Engineering: CRISPR/Cas9 and other genome editing technologies | |
| | 5 | Synthetic biology principles and applications, Bioactuators, Cell free Bioprocessing. | |
| | 6 | Designing and engineering biological systems,. Green and sustainable bioprocess.<br>High-throughput sequencing platforms and methodologies | |
| | 7 | **Protein Engineering**: computational protein design, protein engineering for biomaterials,<br>Enzyme engineering and Biocatalysis and multi specific and bi specific antibodies.<br>Recombinant protein production techniques<br>Monoclonal antibody technology | |
| III | | **Major areas of Innovations II** | **9** |
| | 8 | **Omics Technology**: Next Generation Sequencing, Single Cell omics, Spatial omics and Metagenomics and Microbiomics | |
| | 9 | **Gene synthesis**: High throughput synthesis platforms, Error correction and quality control, Codon optimization and customization and Multi fragment assembly | |
| | 10 | **Metabolic Engineering**: computational tools and algorithm to design and predict metabolic pathways for production of target compounds | |
| IV | | **Industrial aspects of Biotechnology** | |
| | 11 | A brief overview in Bioproduct research and commercialisatiion<br>Nanomaterials in biotechnology applications<br>Targeted drug delivery systems<br>Nanoscale imaging and diagnostics | 9 |
| V | | **Importance of Bio Innovations** | |
| | 12 | Genetically modified organisms (GMOs) and crop improvement<br>Precision agriculture and smart farming technologies<br>Biofuels and sustainable agriculture<br>Case study reports about new innovations in Biotechnology and industrial visit | 9 |

**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | understand the basics and significance of biotechnological innovations, in the development of society | U | PSO-1,4,5 |
| CO-2 | Understand principles of genetic engineering, and learn to utilize various Biotechnology tools for sustainable development and green bioprocessing. | R, U | PSO1,3 |
| CO-3 | Understand application of Omics approaches to analyze industrial and environmental applications of biotechnological processes. | U, | PSO2,5 |
| CO-4 | understand the fundamental theory and practices in bioproduct research and commercialization | U,An | PSO4 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Innovations in biotechnology Credits: 2:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | understand the basics and significance of biotechnological innovations | PSO-1,4,5 | U | F, C | L | |
| CO-2 | understand principles of genetic engineering | PSO1,3 | R, U | P | L | |
| CO-3 | Evaluate industrial and environmental applications of biotechnology | PSO2,5 | U, | C | L | |
| CO-4 | Assess fundamentals of practicing bioproduct research | PSO-1,4,5 | U,An | C | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 1 | - | - | 1 | 2 | - | | | | | | |
| **CO 2** | 2 | - | 1 | - | - | - | | | | | | |
| **CO 3** | - | 2 | - | - | 2 | - | | | | | | |
| **CO 4** | 2 | - | - | 2 | 2 | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |

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# SEMESTER II

University of Kerala

**University of Kerala**

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK2DSCBIT110 | | | | |
| Course Title | BASICS OF CELL BIOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | II | | | | |
| Academic Level | 100 - 199 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 hours | 1 | 2 hours | 5 |
| Pre-requisites | Basic knowledge in life sciences | | | | |
| Course Summary | This course is a foundation level course in the area of cell biology for graduate students. This course provides an overview of the origin and diversity of life on earth. Through this course, learners can acquire basic ideas about the cellular and molecular processes of life. | | | | |

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**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Cell as basic unit of life** | | **5** |
| | 1 | Origin of life – Hypotheses, Experiments to establish the chemical evolution of cell | |
| | 2 | RNA world, Protein world, Nucleoprotein world (progene) hypotheses | |

| | | | |
|---|---|---|---|
| | 3 | Cell as basic unit of life – Prokaryotes and eukaryotes | |
| | 4 | Five kingdom classification | |
| | 5 | Microbes – general features of archaea, eubacteria, protists, fungi | |
| | 6 | Features of plant and animal cell | |
| **II** | **Cell Structure** | | **10** |
| | 7 | Cell Membranes-Structure and Function: Composition of Cell membranes (Membrane lipids, Protein, and Carbohydrates), Fluid Mosaic Model of membrane structure, Membrane transport - Simple diffusion, Facilitated diffusion and Active transport | |
| | 8 | Cell organelles- Structure and Functions: Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus, Vacuole, Cytosol and Cytoskeleton structures (Microtubules, Microfilaments, and Intermediate filaments). | |
| | 9 | Cell Adhesion, Cell Junctions and Extracellular Matrix: Tight Junctions, Adherens Junctions, Desmosomes, and Gap Junctions, ECM- components (Fibrous Proteins, Glycosaminoglycans and Proteoglycans) and its functions | |
| **III** | **Genes, Chromosomes and Genomes** | | **9** |
| | 10 | Genes: Concept and Chemical nature | |
| | 11 | Chromosome structure: Chromatid, Chromonema, Chromomeres, Centromere, Telomere, Secondary Constrictions, Nucleolar Organizers, Satellite, Heterochromatin and Euchromatin Chromosomal aberrations (Structural and numerical) | |
| | 12 | Genomes: Structure and Composition, Size and Complexity, Genome Packaging, Histones and Nonhistones, Nucleosome and Solenoid Model of Chromatin, Giant Chromosomes | |
| **IV** | **Basic cellular processes** | | **12** |
| | 13 | Photosynthesis – Dark and light reaction, Cellular respiration - Glycolysis, Kreb's cycle, ETC and ATP synthesis | |
| | 14 | Cell cycle, cellular growth and differentiation, cell division – mitosis and meiosis, Programmed cell death | |
| | 15 | Gene expression (Brief account only) – Transcription, translation and | |
| | 16 | Overview of cell signalling | |
| **V** | **Methods and techniques in cell biology** | | **9** |
| | 17 | Microscopy (Principle and application only)– Light microscopy, fluorescence microscopy, Electron microscopy (SEM, TEM) | |
| | 18 | Cell staining techniques | |
| | 19 | Cell Lysis, Isolation, purification and detection of proteins and nucleic acids | |

**Practicum (30 Hours)-[ Essential Experiments(15 Hrs), Group/Individual Experiments (15 Hrs) ]**

**Essential Experiments**

1. Light microscope- Identification of its parts and handling
2. Cell counting using haemocytometer
3. Squash preparation of onion root tip and identification of stages of mitosis
4. Calculation of mitotic index
5. Squash preparation of flower buds of *Rhoeo* and identification of stages of meiosis
6. Isolation of genomic DNA
7. Quantification and purity checking of isolated DNA by Spectrophotometry
8. Agarose gel electrophoresis and visualization of DNA bands

**Suggested Readings:**


1. Karp's Cell and Molecular Biology: Concepts and Experiments, 9th Edition (2020) - Gerald Karp, Gerald Karp, and Wallace Marshall; Wiley Publishers
2. The Cell: A Molecular Approach, 9th edition (2023) - Geoffrey Cooper, Kenneth Adams, OUP USA
3. Molecular Biology of the Cell, 7th Edition (2022) - Bruce Alberts, Rebecca Heald, Alexander Johnson et al.; WW Norton & Co
4. Cell Biology, 4th Edition (2017) - Graham Johnson, Jennifer Lippincott-Schwartz, Thomas D. Pollard, William C. Earnshaw, Elsevier - Health Sciences Division
5. Cell Biology (Cytology, Biomolecules and Molecular Biology), 1st Edition (2016) - P S Verma, and V K Agarwal, S Chand Publishing
6. Biology: A Global Approach, Global Edition, 10th Edition (2014) - Reece / Jackson, Pearson
7. Cell And Molecular Biology, 8th Edition (2017) - De Robertis E.D.P.; Lea & Febiger, U.S.


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand common evolutionary history of life and how living things evolve from simplicity to complexity | R | PSO-1 |
| CO-2 | Identify cellular components and explain its functions | R, U, A | PSO-1 |
| CO-3 | Explain the concepts of gene and genome | R, U | PSO-1 |
| CO-4 | Comprehend the basic cellular processes | U, An | PSO-1, PSO -4 |
| CO-5 | Demonstrate and identify various stages of cell cycle under a microscope | U, A, An | PSO-3 |

| | | | |
|---|---|---|---|
| CO - 6 | Isolate genomic DNA and visualize it agarose gel | U, A | PSO-3 |

*R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create*
*Note: 1 or 2 COs/module*

**Name of the Course: Basics of Cell Biology**
**Credits: 2:1:2 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L) /Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| 1 | Understand Common evolutionary history of life | PSO-1, PO-1 | R | F, C | L | |
| 2 | Identify cellular components and explain its functions | PSO-1 PO-1 | R, U, A | P | T | |
| 3 | Explain the concepts of gene and genome | PSO-1 PO-1 | R, U | F,C | L | |
| 4 | Comprehend the basic cellular processes | PSO-1, PSO -4 | U, An | M | L, T | |
| 5 | Demonstrate and identify various stages of cell cycle under a microscope | PSO-3 PO-6 | U, A, An | P | | P |
| 6 | Isolate genomic DNA and visualize it agarose gel | PSO-3 PO-6 | U, A | P | | P |

*F-Factual, C- Conceptual, P-Procedural, M-Metacognitive*

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | - | - | - | - | - | 2 | - | - | - | - | - |
| **CO 2** | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| **CO 3** | 2 | - | - | - | - | - | 1 | - | - | - | - | - |
| **CO 4** | 2 | - | - | 1 | - | - | 2 | 2 | - | - | - | - |
| **CO 5** | - | - | 3 | - | - | - | - | - | - | - | - | 3 |
| **CO 6** | - | - | 3 | - | - | - | - | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

# Multidisciplinary Courses 100-199

University of Kerala

| Discipline | BIOTECHNOLOGY |
|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Course Code | UK2MDCBIT104 | | | | |
| Course Title | FOOD SAFETY, PRESERVATION AND QUALITY MANAGEMENT | | | | |
| Type of Course | MDC | | | | |
| Semester | II | | | | |
| Academic Level | 100 - 199 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 3 | 2 hours | 1 | -s | 3 |
| Pre-requisites | Microbiology,Biochemistry, Animal Physiology | | | | |
| Course Summary | This course provides an in-depth exploration of the principles, practices, and challenges associated with ensuring the safety, preservation, and quality management of food products. It is designed to equip graduate students with advanced knowledge and skills necessary to address complex issues in the food industry, regulatory compliance, and consumer protection. | | | | |

**Detailed Syllabus:**

| Module | Unit | content | Hrs |
|---|---|---|---|
| **I** | | food handling, adulteration and spoilage | **9** |
| | 1 | Food hygiene and health: Concepts of personal hygiene in food handling, Modes of disease transmission through food, Good hygienic practices for food handling | |
| | 2 | Food adulterants: Types of food adulterants- intentional and incidental, metallic adulteration, Adulteration in important food items (milk, fat and oil, food grains, fruits and vegetables, spices, honey and beverages), food adulteration and public health | |
| | 3 | Food spoilage: Types -, physical, chemical and biological spoilage Microbial Food spoilage: Factors affecting microbial growth in food, , Spoilage of canned food | |
| **II** | | **food borne intoxications and infections** | **9** |
| | 4 | Overview of foodborne illnesses: definitions, scope, and significance | |
| | 5 | Causes of foodborne illnesses - Physical hazards, Chemical Hazards and Biological Hazards | |
| | 6 | Foodborne infections- Cholera, Salmonellosis, Shigellosis, Typhoid fever, Brucellosis, E. coli Diarrhoea | |
| | 7 | Foodborne intoxications- Botulism, Staphylococcal food poisoning, Aflatoxins and Mycotoxins. Risk factors for foodborne illness susceptibility and severity | |

| | | | |
|---|---|---|---|
| **III** | **food additives, preservatives, and packaging** | | **9** |
| | 9 | Food preservation –Importance and scope<br>Conventional methods of food preservation (Smoking, Sun drying, Pickling/ Salting, Fermentation) | |
| | | Physical Methods of food preservation- High temperature, Low temperature, dehydration and Concentration, Cold pressing (Fruits, Oils), Ionizing radiation and microwave heating<br>Chemical methods of food preservation – Classification of preservatives- Class I and Class II preservatives ,Food Additives<br>Biological methods of food preservation – Bio-preservation - Fermentation, Use of LAB, Enzymes (e.g. lysozyme) | |
| | 11 | Food packaging: GMP, Methods of food packaging, Types of food packaging materials, bio-packaging materials | |
| **IV** | **food quality management** | | **9** |
| | 13 | Total Quality Management (TQM) principles, Quality control and assurance methodologies | |
| | 14 | Indicator organisms: Food and water quality | |
| | 15 | Food labelling: Purpose and types of food labels | |
| | 16 | Food safety and quality control: Food laws and standards (PFA act, Overview of Codex alimentarius, Agmark, ISO, BIS, FSSAI, HACCP) Regulatory frameworks (FDA, USDA, Codex Alimentarius, etc.). HACCP (Hazard Analysis and Critical Control Points) principles and implementation | |
| **V** | **Familiarize with General Laboratory Techniques** | | **9** |
| | 18 | Water quality analysis– MPN method | |
| | 19 | Isolation and identification of microbes from spoiled food– spoiled milk, meat, fish, vegetables, grains etc. | |
| | 20 | Food preservation techniques: Pickling, salting and drying | |
| | 21 | Detection of adulteration in food (e.g. milk) | |
| | 22 | Preparation of case study report | |
| | 23 | Visit to Food research institutes/ industries | |

**Suggested reading**


1. https://onlinelibrary.wiley.com/doi/full/10.1002/fsn3.3732
2. Food microbiology- MR Adams and MO Moss, 4th edition, Royal Society of Chemistry,2015
3. Industrial microbiology- L E Casida, JR, New Age International Publishers, 2019
4. Basic food microbiology – 2nd edition, George J Banwart, CBS Publishers, 2017
5, Food Microbiology – William C Frazier, 5th edition, McGraw Hill Education, 2017
6. Industrial Microbiology – A H Patel, 2nd edition, Laxmi Publications, 2022
7. Microbiology- L M Prescott, McGraw Hill, 2016


## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|

| | | | |
|---|---|---|---|
| CO-1 | Understand the vital link between food & health | U | PSO-1 |
| CO-2 | Familiarize the microbial diversity associated with food & their role in spoilage/ preservation | R, U | PSO1 |
| CO-3 | Develop Knowledge on organisms identified as leading causes of food borne illness | An | PSO1 |
| CO- 4 | Learn & implement important methods for food preservation for ensuring quality of processed food | Ap | PSO1,4 |
| CO-5 | Impart comprehensive overview of the scientific & technical aspects of food packaging | C,Ap | PSO4 |
| CO- 6 | Instill knowledge on packaging systems, testing & regulations of packaging | E,C | PSO4,5 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Food Safety, preservation and quality management Credits: 2:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand the vital link between food & health | PSO1 | U | F, C | L | |
| CO-2 | Familiarize the microbial diversity of food | PSO1 | R, U | P | L | |
| CO-3 | Develop Knowledge on food borne illness | PSO1 | An | F | L | |
| CO- 4 | Learn & implement food | PSO1,4 | Ap | F | L | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | preservation methods | | | | | |
| CO5 | Impart knowledge of food packaging | PSO4 | C,Ap | | L | |
| CO6 | knowledge on testing & regulations of packaging | PSO4,5 | E,C | | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 1 | - | - | - | - | - | | | | | | |
| **CO 2** | 2 | - | - | - | - | - | | | | | | |
| **CO 3** | 2 | - | - | - | - | - | | | | | | |
| **CO 4** | 2 | - | - | 3 | - | - | | | | | | |
| **CO 5** | - | - | - | 3 | - | - | | | | | | |
| **CO 6** | - | - | - | 3 | 2 | - | | | | | | |

**Correlation Levels:**

| **Level** | **Correlation** |
|---|---|
| - | Nil |
| 1 | Slightly / Low |

| | |
|---|---|
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

# SEMESTER III

# Discipline Specific Core 200-299 Level A3(P)


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University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSCBIT201 | | | | |
| Course Title | MICROBIOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200 – 299 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 hours | 1 | 2 hours | 5 |
| Pre-requisites | Basic knowledge of Biology and Biochemistry | | | | |
| Course Summary | The Microbiology course delves deeply into the microbial world, covering key aspects from past discoveries to practical applications in various fields. It equips students with a strong foundation in microbiology, necessary lab skills, and a thorough understanding of microbial functions, uses, and control methods vital in scientific and industrial contexts. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to the microbial world** | | **6** |
| | 1 | Overview of key events and discoveries in microbial history. Discovery of the microbial world: Establishment of the theory of biogenesis, Contributions of Anton van Leeuwenhoek, Louis Pasteur and Robert Koch | |
| | 2 | Introduction to the prokaryotic world, eukaryotic microorganisms, acellular microorganisms (Viruses, Viroids, Prions) | |
| | 3 | Principles of microbial systematics: Taxonomy, phylogeny, and classification methods | |
| | 4 | Introduction to systems of classification: Binomial Nomenclature, Whittaker's Five Kingdom classification system, Carl Woese's Three Domain classification system, Comparative analysis and utility of different classification systems | |
| **II** | **Principles of microbial control** | | **10** |
| | 5 | Introduction to microbial control principles: Control by killing, inhibition, and removal. | |
| | 6 | Importance and applications of microbial control in various industries and healthcare settings. | |

| | | | |
|---|---|---|---|
| | 7 | Physical Methods of Microbial Control<br>Heat Treatment: Mechanisms and applications of heat in microbial control, including pasteurization and sterilization techniques.<br>Low Temperature Control: Strategies for microbial control using refrigeration and freezing methods.<br>High Pressure and Filtration: Utilizing pressure and filtration techniques for microbial control. | |
| | 8 | Chemical Methods of Microbial Control<br>Modes of Action: Understanding how disinfectants act on microorganisms. Applications | |
| **III** | **Microbial physiology and structure** | | **10** |
| | 9 | Ultra structure of bacteria: Cell wall and internal organisation, spores, | |
| | 10 | Bacterial cell shape and size<br>Motility in bacteria – structure of flagella, types of flagella. | |
| | 11 | Nutritional requirements in bacteria and nutritional categories.<br>Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media | |
| | 12 | Bacterial growth curve, factors affecting the growth of microbes. | |
| **IV** | **Bacterial Genetics and Metabolism** | | |
| | 13 | Bacterial Chromosome, Plasmids, Transfer of genetic information in bacteria, Bacterial mutation and Repair | 10 |
| | 14 | Bacterial Recombination- Transformation, Transduction (Generalised and Specialised), Conjugation | |
| | 15 | Energy Production in Bacteria | |
| | 16 | Aerobic respiration in bacteria: Glycolysis and Krebs cycle, Electron Transport Chain and Oxidative phosphorylation inBacteria<br>Anaerobic respiration in bacteria: Alcohol, Acetic acid and Lactate fermentation | |
| **V** | **Applied Microbiology** | | 9 |
| | 17 | Agricultural microbiology: Biological nitrogen fixation, Mycorrhizal associations, | |

| | | | |
|---|---|---|---|
| | 18 | microbes as biofertilizer – types and application | |
| | 19 | Microbes in extreme condition: role of Methanogenic bacteria, extremophiles – Thermophiles, Acidophiles, Halophiles and Alkalophiles Applications. | |
| | 20 | Case study and industrial visit | |

**Practicals 30 hrs- Essential Experiments (15 hrs) , Group Work (15 hrs)**

**Essential Experiments**

1. Handling Microscope
2. Preparation of smear on slide and focusing on microscope (low power and high power objective).
3. Sterilization and aseptic techniques-preparation and sterilization of glassware and solutions, Autoclaving, Hot air oven
4. Media Preparation- Preparation of Luria-Bertani medium, Nutrient agar and their sterilization (Broth and plates).
5. Serial dilution of bacterial cultures and spread plating (L rod) to find out population density of microbes in a given sample, incubation and observation of colonies
6. Examination of microbial flora of the available soil and water samples. a) Pour plate method, b) Streak plate method - Continuous, Quadrant & T streak.
7. .Staining of bacteria- Gram staining, Acid fast staining, Negative staining.
8. Microscopic tests for bacterial motility- Hanging Drop experiment
9. Identification of bacterial and fungal cultures microscopically.
10. Antibiotics sensitivity assays- Kirby Bauer Method

**Suggested Readings:**


1. A Textbook of Microbiology – P. Chakraborthy, New central Book agency Pvt. Ltd, calcutta
2. Modern concept of Microbiology – D D Kumar, S Kumar; Vikas Publishing House Pvt. Ltd. New Delhi
3. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
4. Introduction to Microbiology- J Heritage, E G V Evans, R A Killington; Cambridge University Press.
5. Microbiology – L M Prescott, Brown Publishers, Australia
6. Advances in Microbiology – J P Tewari, T N Lakhanpal, I Singh, R Gupta and B P Chanola; A P H Publishing Corporation, New Delhi.
7. Microbiology: Principles and Explorations – Jacquelyn G. Black. Prentice Hall, New Jersey.


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understanding the key events in microbial history. | U | PSO-1,2 |
| CO-2 | Explain scope of microbiology and different types of microorganisms. | R, U,A | POS1 |
| CO-3 | Understand Principles of Microbial classification, genetics and metabolism | U,A | PSO1 |
| CO-4 | Understand strategies for microbial control. Analyse disinfectants and their modes of action. | U,Ap,An | POS1,PSO3 |
| CO-5 | Differentiate between culture media types and understand factors affecting microbial growth. | U, An | POS1,PSO4 |
| CO-6 | Gain practical skills in sampling, isolation, staining, and morphology observation. | E, An | PSO3 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course:** The world of microbes **credits: 2:1:2 (lecture:tutorial:practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand History of Microbiology | PSO-1,2 | U | F, C | L | - |
| CO-2 | Explains microbial classification | POS1 | R, U,A | P | L | - |
| CO-3 | Explains principle of microbial control | PSO1 | U,A | F | L | - |
| CO-4 | Analyse the factors affecting microbial Growth | POS1,PSO3 | U,Ap,An | F | L | |
| CO-5 | Understand the requirements to culture microbes in Lab condition | POS1,PSO4 | U, An | P | L | P |
| CO-6 | Gain practical skills in microbiology lab | PSO3 | E, An | P | L | P |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | - | - | - | - | - | | | | | | |
| **CO 2** | 3 | - | - | - | - | - | | | | | | |
| **CO 3** | 3 | - | - | - | - | - | | | | | | |
| **CO 4** | 2 | - | 2 | - | - | - | | | | | | |
| **CO 5** | 2 | - | - | 3 | - | - | | | | | | |
| **CO 6** | - | - | 3 | 2 | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

**Continuous Comprehensive Assessment:**

**Formative :**

- Interactive Quiz /Group Discussions/Assignment/Student Seminar
- Observation of practical skills/Journal Club presentations
- Punctuality in lab, and time management in completing assigned laboratory tasks

**Summative-**Internal test papers/Laboratory book/ report/Periodical lab tests

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Observation of Practical skills | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | ✓ |

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# Discipline Specific Elective courses 200-299 DSE-1

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSEBIT200 | | | | |
| Course Title | BIOPHYSICS AND INSTRUMENTATION | | | | |
| Type of Course | DSE | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 1 | - | 4 |
| Pre-requisites | Basic Physiology, Basic Biochemistry, Fundamentals of Chemistry | | | | |
| Course Summary | Biophysics and Instrumentation is an advanced graduate-level course that explores the interdisciplinary field where physics principles are applied to biological systems. The course integrates concepts from physics, biology, chemistry, and engineering to understand the physical properties of biological molecules and systems. Emphasis is placed on the development and application of various instrumentation techniques to study biological processes at molecular, cellular, and organismal levels. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | **Principles of thermodynamics** | **12** |
| | 1 | Thermodynamics and kinetics of biological processes, energy change in the biochemical reactions | |
| | 2. | Electrical properties of biological compartments: membrane potential, Electricity as a potential signal in biological systems, measuring redox potentials in biological reactions. electrochemical gradients, ATP synthesis, and chemiosmotic hypothesis | |
| **II** | | **Biophysics of physiological events** | **12** |
| | 3. | Biophysics of Photosynthesis - Light reception in plants, microbes and animals. absorption spectra and action spectra of photosynthetic pigments, Fluorescence and phosphorescence | |

| | | | |
|---|---|---|---|
| | 4. | Biophysics of Vision, Muscle movements and Hearing: Mechanism of vision, muscular movements and hearing, correction of vision faults, hearing aids. | |
| | 5. | Intra and inter molecular interactions in the biological system - inter and intramolecular interactions with implications in biological systems. Overview of single-molecule techniques for studying biomolecular interactions and dynamics | |
| **III** | **Basic Instrumentation in Biology** | | **12** |
| | 6. | Electrophoresis: Principle of electrophoresis, types of electrophoresis, 2-D gel electrophoresis | |
| | 7. | Microscopy: Principle of Microscopy, various types of Microscopy - Simple, Phase contrast, Fluorescence and electron microscopy (TEM and SEM). Overview of cryo-electron microscopy, Atomic force microscopy (AFM) Scanning probe microscopy and Confocal microscopy | |
| | 8. | Basic principles and working of instruments: pHmeter, centrifugation, chromatography | |
| | 9. | Overview: Electrophysiological techniques for studying membrane proteins and ion channels | |
| | 10 | Spectrophotometer(UV and Visible) and colorimeter - Beer-Lambert law, atomic absorption spectroscopy, IR, NMR and X-ray Crystallography and Mass Spectrometry. | |
| **IV** | **Isotopes and radioisotopes** | | **12** |
| | 11. | Application of isotopes and radioisotopes in biological research | |
| | 12. | Overview: Introduction to computational modelling and simulation methods in biophysics.Molecular dynamics simulations for studying biomolecular structure and dynamics. Bioinformatics tools for sequence analysis, protein structure prediction, and systems biology | |
| **V** | **Applications of Biophysics and Instrumentation** | | **12** |
| | 13. | Drug discovery and development.<br>Biomedical imaging and diagnostics. Biophysical approaches to understanding disease mechanisms.<br>Emerging trends and future directions in biophysics research. Case study reports for radiotracer techniques | |
| | 14. | Submit a report/flowchart for elucidation of the structure of plant metabolites | |

**Familiarize with the following techniques**

1. pH Meter–Use of pH Meter, Familiarization of the instrument and Preparation Phosphate buffers and determination of pH.

2. Spectrophotometer–Familiarization of the working of the instrument, Quantitative estimation of Sugars by Dinitrosalysilic acid and Proteins by Lowry's Method
3. Development of absorption spectra of chlorophyll or any other biological sample
4. Electrophoresis–demonstration of PAGE and Agarose Gel Electrophoresis

**Suggested Readings**


1. Nelson, D. L., & Cox, M. M. (Year). *Lehninger's Biochemistry*. New York, NY: Worth Publishers.
2. Voet, D., & Voet, J. G. (Year). *Biochemistry*. Boston, MA: Jones & Bartlett
3. Roy, R. N. (Year). *A Textbook of Biophysics*. Calcutta, India: New Central Book Agency Pvt. Ltd.
4. Nair, A. J. (Year). *Introduction to Genetic Engineering & Biotechnology*. Boston, MA: Jones & Bartlett Publishers.
5. Volkenstein, M. V. (Year). *Biophysics*.
6. Cantor, C. R., & Schimmel, P. R. (Year). *Biophysical Chemistry*.
7. Phillips, R., Kondev, J., Theriot, J., & Garcia, H. (Year). *Physical Biology of the Cell*.
8. Lakowicz, J. R. (Year). *Principles of Fluorescence Spectroscopy*.


## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand how energy changes and conservation in the biochemical reactions is maintained | U | PSO 1, 2 |
| CO-2 | Understand the functioning of physiological events like vision, muscle movement and hearing and various types of biological interactions. | R, U | PSO 1 |
| CO3 | Understand basic instrumentation to analyse, elucidate and interpret a biomolecule | R U, An | PSO 3, 4 |
| CO4 | Analyse the use of isotopes and radioisotopes in understanding the biochemical and physiological events in biology. | R, U, An | PSO 3 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Biophysics and instrumentation Credits: 3:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand the concepts of energy conservation and changes in biological system | PSO-1,2 | U | F, C | L | |
| CO-2 | Understand the biophysics of basic physiological system | PSO1 | R, U | P | L | |
| CO3 | Understand Basic instrumentation to elucidate the structure of molecules | PSO3,PSO4 | R U, An | F, P | L | P |
| CO4 | Analyser the techniques follow up metabolic pathways | PSO3 | R, U, An | P | L | - |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 3 | - | - | - | - | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 2** | 3 | - | - | - | - | - | | | | | | |
| **CO 3** | - | - | 3 | 4 | - | - | | | | | | |
| **CO 4** | - | - | 2 | - | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |

# Value Added Courses 200-299

University of Kerala

| | |
|---|---|
| Discipline | BIOTECHNOLOGY |
| Course Code | UK3VACBIT200 |

| | | | | | |
|---|---|---|---|---|---|
| Course Title | IPR,BIOETHICS AND BIOSAFETY | | | | |
| Type of Course | VAC | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 3 | 2 hours | 1 | | 3 |
| Pre-requisites | Essentials of Biotechnology | | | | |
| Course Summary | This course provides an in-depth exploration of the intersection of intellectual property rights, bioethics, and biosafety within the context of modern scientific research and biotechnology. It aims to equip students with a comprehensive understanding of the legal, ethical, and safety considerations inherent in the development, dissemination, and regulation of biotechnological innovations. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | **Basics of Intellectual Property Rights** | **9** |
| | 1 | **Basics of Intellectual Property Rights**<br>Types of IPR-industrial-patent(types),design, trademark,trade secret, GI; non industrial-copyright(types, infringement, exclusions), Patentable and non-patentable, patenting life, Rights of traditional knowledge holders , Peoples biodiversity register | |
| | 2 | legal protection of biotechnological inventions, Pros & Cons of IP, World Intellectual Property Right Organization(WIPO), TRIPS agreement, UPOV convention<br>Patent Infringement(Case Study), Plagiarism, plagiarism detection softwares and ways to avoid plagiarism | |
| **II** | **Biosafety** | | **9** |
| | 3 | Biosafety-Different levels of Biosafety, Biosafety levels of specific Microorganisms; | |

| | | | |
|---|---|---|---|
| | 4 | Recommended Biosafety levels for Infectious agents and Infected animals, Biosafety Issues in Biotechnology, Biological Safety Cabinets; Containments- Types. | |
| | 5 | Examine the principles and practices of biosafety in laboratory and industrial settings.<br>Evaluate risk assessment methodologies and strategies for mitigating biological hazards.<br>Discuss regulatory frameworks and guidelines for biosafety compliance, including containment protocols and waste management. | |
| | 6 | Basic Laboratory and Maximum Containment Laboratory | |
| **III** | **Guidelines of Biosafety** | | **9** |
| | 7 | Guidelines of Biosafety<br>Biosafety guidelines and regulations (National and International) – Operation at National level; GMO's and LMO's – Definition, | |
| | 8 | Institutional Biosafety Committee, RCGM, GEAC, for GMO applications in Food and Agriculture, | |
| | 9 | Assessment and management of risks associated with GMO | |
| **IV** | **Bioethics** | | **9** |
| | 10 | Bioethics -Introduction. key concepts and principles in bioethics, including autonomy, beneficence, nonmaleficence, and justice.<br>Animal Ethics, Animal Rights, Biotechnology and Ethics | |
| | 11 | Ethical issues related to research in embryonic stem cell cloning | |
| | 12 | Ethical, Legal and Social Implications (ELSI) of Human Genome Project. | |
| **V** | **Essentials of scientific experiments** | | **9** |
| | 13 | Values in science, Misconduct in science, Negligence and error, Conflict of interest, Techniques used and treatment of data | |
| | 14 | Analyze case studies and real-world examples to understand the practical application of IPR in biotechnology. | |
| | 15 | Debate contemporary bioethical issues such as gene editing, and access to healthcare. | |

**Suggested Reading**


1. Intellectual Property Rights: A Practical Guide to Content, Protection, and Exploitation" by Stephen Johnson
2. "Intellectual Property: A Very Short Introduction" by Siva Vaidhyanathan
3. "Intellectual Property in the New Technological Age" by Robert P. Merges and Peter S. Menell
4. Bioethics: Principles, Issues, and Cases" by Lewis Vaughn
5. "Principles of Biomedical Ethics" by Tom L. Beauchamp and James F. Childress
6. "Bioethics: An Introduction" by Marianne Talbot
7. Biosafety in Microbiological and Biomedical Laboratories" by Centers for Disease Control and Prevention (CDC) and National Institutes of Health (NIH)
8. "Biosafety in Industrial Biotechnology" by Preeti Jain and Rakesh Singh
9. "Handbook of Laboratory Health and Safety" by Robert H. Hill Jr. and David W. Smith


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand basics of Intellectual Property Rights and various treaties associated with it at international level | R ,U | PSO-2,5 |
| CO-2 | Awareness about legal protection of biotechnological inventions | U | PSO-2,5 |
| CO3 | Awareness about Biosafety levels at specific Microorganisms level and biosafety regulations | U | POS5 |
| CO4 | Understand Ethical issues related to research in different areas of Biotechnology | U | PSO5 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: IPR,bioethics and biosafety Credits: 2:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understood IPR and treaty's | PSO-2,5 | R ,U | F, C | L | P |
| CO-2 | Awareness about legal protection to Biological inventions | PSO-2,5 | U | P | L | |
| CO3 | Awareness about Biosafety levels | PSO5 | U | F | L | |
| CO4 | Understand Ethical issues related to biological research | PSO5 | U | C | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | - | 2 | - | - | 3 | - | | | | | | |
| **CO 2** | - | 3 | - | - | 3 | - | | | | | | |
| **CO 3** | - | - | - | - | 2 | - | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 4** | - | - | - | - | 3 | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

## Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| | | | | |

# SEMETER IV

University of Kerala

| | |
|---|---|
| Discipline | BIOTECHNOLOGY |

| | | | | | |
|---|---|---|---|---|---|
| Course Code | UK4DSCBIT207 | | | | |
| Course Title | MOLECULAR BIOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | IV | | | | |
| Academic Level | 200 - 299 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 hours | 1 | 2 hours | 5 |
| Pre-requisites | Essentials of Biotechnology<br>Basic understanding on Genetics and DNADNA structure | | | | |
| Course Summary | This core-course imparts an essential foundation for understanding of mechanisms and regulations of gene expression at molecular level. Understanding the molecular basis of life is very important to apply manipulation strategies in the future for genetic engineering and genome editing. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | **Molecular basis of life** | **8** |
| | 1 | History and significant discoveries in molecular biology, Classicexperiments demonstrating DNA as the genetic material | |
| | 2 | Structure of DNA, Central dogma of molecular biology | |
| | 3 | Eukaryotic chromosomes- molecular organization, nucleosomes. | |
| | 4 | Replication of DNA(prokaryotic and eukaryotic), enzymes involved in DNA replication, Replication fork, action of telomerase. | |
| **II** | | **Gene expression I** | **10** |
| | 5 | Transcription(Prokaryotic and Eukaryotic)- mechanism | |
| | 6 | RNA Polymerase, promoter, transcription factors | |
| | 7 | Types of RNA-mRNA, tRNA, rRNA and small nuclear RNA (snRNA), mi RNA. | |
| | 8 | Post-transcriptional modification of mRNA in eukaryotes-capping, tailing and splicing mechanisms. | |
| **III** | | **Gene expression II** | **10** |
| | 9 | Organisation of prokaryotic and eukaryotic gene- split genes, introns and exons, reading frame, enhancers and silencers | |

| | | | |
|---|---|---|---|
| | 10 | Genetic code - properties of genetic code, Codons, codon assignment, redundancy and wobble theory(CS) | |
| | 11 | Translation- mechanism of translation in prokaryotic and eukaryotic mRNA | |
| | 12 | Post translational modification of proteins (CS), Extrachromosomal Inheritence | |
| **IV** | **Gene regulation** | | **8** |
| | 13 | Prokaryotic gene regulation, operon, (lac and trp operon), catabolic repression, attenuation | |
| | 14 | Eukaryotic gene regulation; levels of control of gene expression, epigenetics (CS) | |
| | 15 | Regulation of RNA processing, mRNA degradation and protein degradation control, RNA interference, microRNAs, RNA interference,Translational regulation: riboswitches, RNA-binding proteins | |
| | 16 | Genome Editing Technologies<br>Zinc finger nucleases (ZFNs), Transcription Activator-Like Effector Nucleases (TALENs)<br>CRISPR-Cas9 system: mechanism and applications | |
| | 17 | Non-coding RNAs: long non-coding RNAs (lncRNAs), circular RNAs (circRNAs)<br>Synthetic biology: designing biological systems for specific purposes | |
| **V** | **Tools and Techniques in Molecular Biology** | | **9** |
| | 18 | DNA isolation: Principle and Protocol, Purification and quantification methods- UV Spectrophotometry | |
| | 19 | Gel electrophoresis- Principle and applications in separating macromolecules. | |
| | 20 | PCR, Southern Blotting , Microarray- mRNA isolation, cDNA synthesis, expression profiling | |
| | 21 | Protein isolation, purification, western Blotting, enzyme assays | |

**Practicals 30 hrs- (Essential Experiments (15 hrs) , Group Work (15 hrs)**

**Essential Experiments**

1. Familiarisation of instruments and equipments used in molecular biology laboratory
2. Preparation of solutions and buffers for DNA isolation
3. Isolation of Genomic DNA from a suitable source- bacteria, plant or animal tissue
4. Examination of the purity of DNA by agarose gel electrophoresis.
5. Quantification of DNA by UV-spectrophotometer
6. Isolation and purification of plasmid DNA
7. Agarose gel analysis of plasmid DNA
8. Extraction of Protein and RNA from plant samples.
9. Visit a molecular biology laboratory within the entire course tenure

**Suggested Reading:**

1. Applied Molecular genetics – R L Miesfeld; Wiley.Liss, New Delhi.

3. Essential molecular Biology- A practical Approach, T A Brown; Oxford, New York

4. Gene VIII- Benjamin Lewin; Oxford University Press.

5. Molecular Biology, PS Verma and VK Agarwal, S.Chand & Company pvt Ltd, New Delhi

6. Introduction to Molecular biology- P. Paolella; McGraw Hill, New York

7. Molecular Biology of the gene – Watson, Baker, Bell Gann, Lewinw, Losick; Pearson Education Pvt.Ltd, New Delhi

8. Molecular cell biology, H S Bhamrah; Anmol Publications Pvt. Ltd., New Delhi.

9. PCR 3 - Practical Approach – C. Simon Hearington& John J O'Leary; Oxford, New York

10. Principles of Gene manipulation- R.W.Old& S.B. Primrose; Blackwell Scientific Publications

11. M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor, ed. 4, 2012).

12. M. M. Burell. Enzymes of Molecular Biology (Humana Press, 1993).

## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand the concept of gene, its structure and expression | R, U | PSO-1,2 |
| CO-2 | Differentiate the mechanism of DNA replication in prokaryotes with eukaryotes | U, An | PSO1 |
| C0-3 | Understand the gene regulation mechanisms in a living cell | R, U | PSO1,PSO3 |
| CO-4 | Analyse the purity of a given DNA sample by UV spectrophotometry | U, An | PSO3,4 |
| CO-5 | Understand how the genome is compacted to chromosome level | R, U | PSO3,4 |
| CO-6 | Handle DNA samples for quantification, subjecting the sample to separation by gel electrophoresis | An, Ap | PSO3 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course:** Molecular Biology **Credits: 2:1:2 (Lecture:Tutorial:Practical)**

| **CO No.** | **CO** | **PO/PSO** | **Cognitive Level** | **Knowledge Category** | **Lecture (L)/Tutorial (T)** | **Practical (P)** |
|---|---|---|---|---|---|---|
| CO-1 | Understand the concept of gene | PSO-1,2 | R, U | F, C | L | |
| CO-2 | Differentiate prokaryotic and eukaryotic replication | PSO1 | U, Ap | C, P | L | |
| CO-3 | Understand the gene regulation | PSO1,PSO3 | U, An | F,C | L | |
| C0-4 | Analyse DNA sample purity | PSO3,4 | An,Ap | P | | P |
| CO-5 | Understand genome compaction | PSO3,4 | R,U | F,C | L | |
| CO-6 | Handling DNA, for quantification and gel electrophoresis | PSO3 | An,Ap | C, P | | P |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 3 | - | - | - | - | | | | | | |
| **CO2** | 2 | - | - | - | - | - | | | | | | |
| **CO3** | 2 | - | 3 | - | - | - | | | | | | |
| **CO4** | - | - | 2 | 3 | - | - | | | | | | |
| **CO5** | - | - | 3 | 3 | - | - | | | | | | |
| **CO6** | - | - | 3 | - | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

**Continuous Comprehensive Assessment:**

**Formative :**

- Interactive Quiz

- Group Discussions
- Assignment
- Student Seminar
- Observation of practical skills
- Journal Club presentations
- Punctuality in lab, and time management in completing assigned laboratory tasks

**Summative**

- Internal test papers
- Laboratory book/ report
- Periodical lab tests

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Observation of practical skills | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | ✓ | | ✓ | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

# Discipline Specific Elective courses 200-299, DSE2

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK4DSEBIT204 | | | | |
| Course Title | BIOINFORMATICS | | | | |
| Type of Course | DSE | | | | |
| Semester | IV | | | | |
| Academic Level | 200 - 299 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 hours | 1 | 2 | 5 |
| Pre-requisites | Essentials of biotechnology, Molecular Biology | | | | |
| Course Summary | Bioinformatics is a multidisciplinary subject that is a combination of studies related to Life Science, Computer Languages, Data Science, Systems Biology and Basic Engineering. This course is intended to introduce the subject of bioinformaticsto the students of biotechnology, to empower them with the skills of computational biology, to analyse and process data using bioinformatics tools.This course will familiarise students to the importance of role of *omics* in the better learning of Systems Biology in a holistic way. The basic learning of this Bioinformatics course will help them to pursue a career in Bio Analytics, Data Analytics, Proteomics, Pharmacology and AI. | | | | |

Detailed Syllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **introduction to bioinformatics** | 6 |
| | 1 | History and evolution of bioinformatics, Scope and impact of bioinformatics in Life Science research. | |
| | 2 | Introduction to Systems Biology, Generation of large scale molecular biology data | |
| | 3 | Databases and DBMS, Biological Databases- Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary).Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum). Data mining | |

| | | | |
|---|---|---|---|
| | 4 | Fundamentals of programming languages and statistical methods in Bioinformatics | |
| II | **sequence alignment** | | 10 |
| | 5 | Sequence homology Vs Similarity | |
| | 6 | Sequence alignment- Global and Local alignment- Dynamic programming | |
| | 7 | Pairwise alignment (BLAST and FASTA Algorithm) | |
| | 8 | Multiple sequence alignment (Clustal W and PRAS algorithm). | |
| III | **structural bioinformatics** | | 10 |
| | 9 | Levels of protein structure, structure prediction methods for proteins' secondary (Chou Fasman) and tertiary structures (Homology Modeling) | |
| | 10 | Introduction to Molecular Docking and docking softwares. | |
| | 11 | Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization. | |
| | 12 | Applications of Structural Bioinformatics | |
| IV | **Applications I: omics** | | 10 |
| | 13 | Genomics: Genome architecture, types of genome & its components, genome annotation, Parsing<br>Structural Genomics, Functional genomics, Comparative Genomics, Metagenomics | |
| | 14 | Metabolomics: Concept of Metabolome and Metabolic pathways(KEGG) | |
| | 15 | Proteomics – technology of protein expression analysis, 2D PAGE, MS, Protein identification through database search, PDB | |
| | 16 | Applications of genomics and proteomics | |
| V | **Applications II** | | 9 |
| | 17 | Bioinformatics tools for Phylogenetic analysis- tree construction- distance based methods and character based methods, PHYLIP | |
| | 18 | Drug Discovery and design : Target identification , Target Validation , Lead Identification , lead optimization, | |

| | | | |
|---|---|---|---|
| | | Chemoinformatics tools for drug discovery; ChemBank, PUBCHEM | |
| | 19 | AI driven tools of Bioinformatics; DRAGEN, Rosetta, DeepVariant | |
| | 20 | Future potential of Bioinformatics | |

**Practicals 30 hours-Essential practical -15 0hrs, group or individual work 15 hours**

**Essential Experiments**

1. Sequence Analysis: Sequence Alignment: Use tools like BLAST, ClustalW, or MUSCLE for pairwise or multiple sequence alignments. Analyze the results to identify conserved regions, mutations, or evolutionary relationships.

2. Sequence Searching: Perform database searches using tools like NCBI BLAST or HMMER to identify similar sequences in large databases such as GenBank or UniProt.

3. De Novo Genome Assembly: Assemble short reads generated from high-throughput sequencing platforms (e.g., Illumina) into longer contiguous sequences (contigs) using assemblers like Velvet, SPAdes, or SOAPdenovo.

4. Phylogenetic Tree Construction: Construct phylogenetic trees using molecular sequence data (DNA or protein) with programs like PHYLIP, RAxML, or MrBayes.

**Suggested reading**


1. Statistical Methods in Bioinformatics: An introduction, Ewens, W. J. and Grant, G. R. Springer, 2001
2. Programming Languages-Concepts and Constructs, Sethi R, 2nd Edition, Pearson
3. Introduction to Bioinformatics –5th Edition, Lesk A. M, Oxford
4. From Genes to Genomes, Concepts and Applications of DNA Technology, third edition, Jeremy W. Dale, Malcolm von Schantz , Nicholas Plant, Wiley Blackwell, 2011
5. Introduction to Proteomics: Tools for the New Biology, Liebler D., Springer Science + Business media, LLC
6. “Introduction to Data mining with case studies”, G.K. Gupta, PHI Private limited, New Delhi, 2008.
7. An Introduction to Bioinformatics Algorithms Neil C. Jones and Pavel A. Pevzner
8. Bioinformatics and Computational Biology Solutions Using R and Bioconductor, Robert Gentleman, Vincent Carey, Wolfgang Huber, Rafael Irizarry, Sandrine Dudoit, Oxford University Press
9. "*Bioinformatics*: *Sequence and Genome Analysis*" by David W. Mount, 2nd edition, 2004
10. Bioinformatics - A Practical Guide to the analysis of Genes and Proteins-Andreas Baxevanis&B.F.Francis Ouellette. ISBN: 978-0-471-46101-2, Wiley

11. Developing Bioinformatics Computer Skills, first edition, 2001,Jambeck P, Gibas .C. ISBN: 1-56592-664-1, O'Reilly
12. Primrose S.B, TwymanR.m., and Old R.w., Principles of gene manipulations, 6th ed, 2002, Blackwell publishers, Oxford.
13. S C Rastogi, N Mendiratta and P Rastogi, " Bioinformatics: Methods and Applications" , ISBN : 978-81-203-4785-4, PHI Learning Private Limited, 2015.
14. Attwood, T.K., Parry, D.J., Smith, Introduction to Bioinformatics, Pearson Education, 2005.

## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand the scope and impact of Bioinformatics in Data analysis in life science research | U, An | PSO1 |
| CO-2 | Demonstrate different categories of databases and their utility | R, U, An | PSO4 |
| CO-3 | Understand the various applications of omics approaches | U, Ap | PSO4 |
| C0-4 | Use Molecular Visualisation tools to study molecular structures proteins | U, Ap | PSO1,4 |
| CO-5 | Compare and analyze biological sequences to interpret the results of their analyses. | U, An, E | PSO3,4 |
| CO-6 | Search and retrieve information from genomic and proteomic databases by data mining tools | U, Ap | PSO3,4 |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

*Note: 1 or 2 COs/module*

**Name of the Course: Bioinformatics Credits: 2:1:2 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| CO-1 | Understand the scope and impact of Bioinformatics | PSO1 | U, An | F, C | L | |
| CO-2 | Demonstrate different categories of databases | PSO4 | R, U, An | F, C, P | L | |
| CO-3 | Understand the various applications of omics approaches | PSO4 | U, Ap | F,C, P | L | |
| C0-4 | Use Molecular Visualisation tools to study molecular structures proteins | PSO1,4 | U, Ap | F,C, P | L | P |
| CO-5 | Compare and analyze biological sequences | PSO3,4 | U, An, E | F,C, P | L | |
| CO-6 | Search and retrieve biological informations | PSO3,4 | U, Ap | C, P | L | |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | - | - | - | - | - | 1 | | | | | | |
| CO 2 | - | - | - | 3 | - | - | 2 | | | | | | |
| CO 3 | - | - | - | 2 | - | - | 2 | | | | | | |
| CO 4 | 2 | - | - | 3 | - | - | 3 | 1 | | | | | |
| CO 5 | - | - | 3 | 3 | - | - | 3 | | | | | | |
| CO 6 | - | - | 3 | 3 | - | - | 2 | | | | | | 1 |

Correlation Levels:

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics:

Quiz / Assignment/ Quiz/ Discussion / Seminar/Midterm Exam

Programming Assignments/Final Exam /Mapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | | | ✓ |
| CO 5 | | | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 6 | ✓ | | | ✓ |

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# Value added Courses 200-299

**University of Kerala**

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK4VACBIT201 | | | | |
| Course Title | GOOD LABORATORY PRACTICES AND QUALITY CONTROL IN BIOTECHNOLOGY | | | | |
| Type of Course | **VAC** | | | | |
| Semester | IV | | | | |
| Academic Level | 200 - 299 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 3 | 2 hours | 1 | | 3 |
| Pre-requisites | Essentials of Biotechnology, Microbiology | | | | |
| Course Summary | This course provides students with a comprehensive understanding of good laboratory practices (GLP) and quality control (QC) in the field of biotechnology where students will learn the importance of adhering to GLP guidelines and implementing QC measures to ensure the reliability, reproducibility, and accuracy of experimental results in biotechnological research and industry. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Good Laboratory Practices (GLP)** | | **9** |
| | 1 | Historical perspective, Definition, purpose, Principles | |
| | 2 | Lab rules for best lab practices, aseptic lab procedures, Facility design, equipment calibration and maintenance, personnel training, and responsibilities. | |
| | 3 | Documentation and Record Keeping -maintenance of records and log books,<br>Equipment Calibration and Maintenance. | |
| | 4 | Handling, sampling, storage and SOP. | |
| **II** | **Biosafety, hazards, risks and management** | | **9** |
| | 5 | Types of hazards – Biological hazards, physical hazards, chemical hazards, Symbols in biohazards. | |

| | | | |
|---|---|---|---|
| | 6 | Risk assessment and management- containment facility, biosafety level and its classification. Assessment of biological hazards, Risk assessment process examples and tools, Biosafety measures and Guidelines. | |
| | 7 | Types of laboratory wastes and methods of disposal of laboratory wastes- Chemical, Physical and Biological. | |
| | 8 | Classification of chemicals and hazard levels. | |
| **III** | **Regulations in QC and validation** | | **9** |
| | 9 | Overview of GLP and QC regulations, guidelines, and standards applicable in biotechnology. Government regulations and amendments and national and international standards – FDA, ISI, Codex , ISO,OECD.Role of FDA in India. | |
| | 10 | Hazard analysis and quality control analysis – HACCP- Significance, Seven Principles– Significance GLP. | |
| | 11 | Activities – Design qualification (DQ), Installation qualification (IQ), Operational qualification (OQ), Performance qualification (PQ) | |
| **IV** | **Quality control in biotechnology industry** | | **9** |
| | 12 | Implementation of QA/QC systems to monitor and ensure the quality of processes, products, and data. Quality management and quality assurance in BI | |
| | 13 | Identification, assessment, and mitigation of potential risks to quality and compliance. GMP as an element in QC- Importance of QC in BI | |
| | 14 | Principles and procedures for validating and verifying analytical methods used in biotechnology. Sampling, inspection, testing, of raw and packaging materials,product, release and rejection of batches. | |
| **V** | **Assesment** | | **9** |
| | 15 | Write an overview of quality management in a Pharmaceutical/Food industry/Beverage industry after visiting one of your choice.<br><br>Case Studies and Best Practices: Examination of real-world case studies and best practices in GLP and QC implementation within the biotechnology industry. | |

**Suggested Reading**


1. "Good Laboratory Practice Regulations" by CRC Press
2. "Quality Control in the Pharmaceutical Industry" by CRC Press
3. "Laboratory Quality Management System: Handbook" by WHO
4. "Statistical Methods for Quality Control" by John Wiley & Sons
5. "Good Clinical, Laboratory and Manufacturing Practices: Techniques for the QA Professional" by CRC Press
6. International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH) guidelines
7. United States Pharmacopeia (USP) standards
8. Food and Drug Administration (FDA) regulations
9. World Health Organization (WHO) guidelines on GLP and QC in biotechnology
10. "Good Clinical, Laboratory and Manufacturing Practices: Techniques for the QA Professional" by CRC Press


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Explain the significance of adhering to good laboratory practices (GLP) in biotechnological research and industry and understand the principles and methods of GLP | U | PSO1 |
| CO-2 | Classify the different types of hazards, biosafety levels, wastes, assess the risks and evaluate the various biosafety levels in handling the same. | An, A | PSO3 |
| CO3 | Understand the various regulation at national and international levels in QC and validation and identify the principles of HACCP | R, U | PSO3 |
| CO4 | Describe the significance and methods of QC in biotechnology industry | U | PSO5 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course:** Good laboratory practices and quality control in biotechnology **Credits: 2:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understood principles of good Lab Practices | PSO1 | U | F | L | |
| CO-2 | Understood about Biohazards and different Biosafety levels | PSO3 | An, A | F | L | P |
| CO3 | Understand the various regulation at national and international levels in QC | PSO3 | R, U | F | L | |
| CO4 | Describe the significance in Biological research | PSO5 | U | C | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | | | | | | | | | | | | | |
| **CO 2** | | | 3 | | | | | | | | | | | |
| **CO 3** | | | 3 | | | | | | | | | | | |
| **CO 4** | | | | | 3 | | | | | | | | | X |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

## Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | | | ✓ |

# Skill enhancement Courses 200-299

**University of Kerala**

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK4SECBIT201 | | | | |
| Course Title | BASICS OF PHYTOCHEMISTRY AND MEDICINAL PLANT-BASED INDUSTRY | | | | |
| Type of Course | SEC | | | | |
| Semester | IV | | | | |
| Academic Level | 200 - 299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 3 | 2 hours | 1 | - | 3 |
| Pre-requisites | Biochemisty,Bioinstrumentation | | | | |
| Course Summary | The course gives a basic idea on phytochemistry and various techniques involved in harnessing active constituents from plants and looking for their potential applications in pharmaceutics. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to phytochemistry and medicinal plant-based industry** | | **9** |
| | 1 | Natural products from plants, History | |
| | 2 | Phytochemical evaluation of plant drugs, morphological, organoleptic, microscopic, and biological study of aromatic plants | |
| | 3 | Applications of Phytochemistry and Phytochemicals | |
| | 4 | medicinal and aromatic plant-based industries – phytopharmaceutical products, use in indigenous medicine, bioprospecting and introduction to access and benefit sharing | |
| | 5 | Pharmacology and pharmacognosy | |
| **II** | **Extraction and characterisation techniques** | | **9** |
| | 5 | Types and principles of extraction – cold, hot - Soxhlet, steam distillation, solid-liquid extraction, Clevenger apparatus. | |
| | 6 | Separation and characterisation techniques- Chromatography types- TLC, HPLC, GC-MS, HPTLC, UV-visible spectroscopy, IR spectroscopy, NMR. | |
| **III** | **Active principles from plants** | | **9** |
| | 7 | Primary and secondary metabolic pathways (shikimic – chorismic, mevalonate pathways) and metabolites | |
| | 8 | Types and features of active constituents, quality purity and pharmaceutical use. | |
| | 9 | Classification of phytochemicals, Sources, Biosynthesis, extraction, isolation, identification and therapeutic applications-Alkaloids, Flavonoids, Phenolics, Terpenes, Volatile oils. | |
| | 10 | Adulteration and alternation- Detection methods. | |

| | | | |
|---|---|---|---|
| | 11 | Metabolic Engineering | |
| **IV** | **Type study of a few important medicinal plants** | | **9** |
| | 12 | Utilization of Medicinal Plants in Pharmaceuticals, Drug discovery from natural sources,Development of plant-based medicines,Formulation and dosage forms | |
| | 13 | Study of medicinal plants, methods of extraction, therapeutic uses- *Ocimum sanctum, Aegle marmalos, Cymbopogancitratus*, *Curcuma longa, Santalum album, Aloe barbadensis* | |
| **V** | **Herbal Products and Nutraceuticals** | | **9** |
| | 14 | ,Dietary supplements,Functional foods,Herbal cosmetics | |
| | 15 | Regulatory Aspects and Quality Control,Good Manufacturing Practices (GMP),Quality control parameters (purity, potency, identity),Safety and toxicological assessment,Ethical considerations in wild harvesting | |
| | 16 | Case study report of Taxol, artemisinin, Antioxidants from seaweeds | |

**Suggested reading**


1. Phytochemical Methods A Guide to Modern Techniques of Plant Analysis by JB Harborne. Springer, 1998**.**
2. Krishnaswamy, N. R., 2003. Chemistry of Natural Products. Universities press, Hyderabad
3. Daniel, M., 1991. Methods in Plant chemistry and Economic Botany. Kalyani publishers, New Delhi
4. Phytochemistry- Vol 1- Fundamentals, Modern techniques, and applications, ChukwuebukaEgbuna, Ifemeje, J. C (Editors). CRC Taylor & Francis, 2019.
5. Biren, Shah and Seth, A. K. Textbook of Pharmacognosy and Phytochemistry. New Delhi: Elsevier, 2010.


## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Summarise the various natural products and apply the methods of phytochemical evaluation. Identify the various process in bioprospecting and importance of access and benefit sharing. | R, U, A | PSO1 |
| CO-2 | Distinguish among the various extraction and characterisation techniques of phytochemicals | An | PSO1 |

| | | | |
|---|---|---|---|
| CO3 | Understand the various metabolic pathways and classify among the various phytochemicals involved and list the pathway manipulation techniques | R, U, A | PSO3 |
| CO4 | Identify a few important medicinal plants and compare the various methods of extraction of phytochemicals and their uses. | R, U | PSO1 |
| CO5 | Demonstrate the various techniques for extraction and analysis of any one phytochemical of choice | A | PSO3 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Basics of Phytochemistry and Medicinal plant-based Industry Credits: 2:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO1 | Understand phytochemicals and its various application | PSO1 | R, U, A | F | L | |
| CO-2 | Understand the extraction principles of various phytochemicals | PSO1 | An | F | L | |
| CO3 | Awareness about metabolic pathway and its manipulation for improved production and extraction | PSO3 | R, U, A | C | L | |
| CO4 | Evaluate the traditional medicinal plants and bioactives | PSO1 | R, U | F | L | P |
| CO5 | Skilled in phytochemical extraction methods | PSO3 | A | P | - | P |

| | PSO1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PSO 7 | PSO 8 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | | | | | | | | | | | | | |
| **CO 2** | 3 | | | | | | | | | | | | | |
| **CO 3** | | | 3 | | | | | | | | | | | |
| **CO 4** | 2 | | | | | | | | | | | | | |
| **CO 5** | | | 3 | | | | | | | | | | | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

## Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 4 | ✓ | | | ✓ |
| CO 5 | ✓ | | | ✓ |

# UK4INTBIT200 SUMMER INETRNSHIP

# Credit-2

**All the students shall undergo internship/apprentiship in a firm/industry or training in labs with faculty and researchers in their institution or other HEIs/research institutions during the summer term. The internship has two credits and shall be completed in the first three years of FYUGP. The department council of the HEI shall approve the firm/Institution from where the student shall undergo an internship after verifying the quality and geniness of the firm /Institution**

# SEMESTER V

University of Kerala

| Discipline | BIOTECHNOLOGY |
|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Course Code | UK5DSCBIT300 | | | | |
| Course Title | RECOMBINANT DNA TECHNOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | V | | | | |
| Academic Level | 300 - 399 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 hours | 1 | 2 hours | 5 |
| Pre-requisites | Basic Knowledge in Cell biology, genetics & molecular biology | | | | |
| Course Summary | This core-course aims to acquaint students with the tools and techniques employed in genetic engineering and recombinant DNA technology. This knowledge enables students to innovatively apply this technique in basic and applied fields of biological research involving gene manipulation. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | **Introduction to gene cloning**: | **6** |
| | 1 | History and milestones in the development of recombinant DNA technology | |
| | 2 | Restriction endonucleases, classification and general characteristics of RE | |
| | 3 | Other DNA modifying Enzymes- DNA polymerase, DNA ligase, alkaline phosphatase, Polynucleotide kinase, Terminal transferase, Reverse Transcriptase | |
| | 4 | Adaptors, Linkers, Homopolymer tailing | |
| **II** | | **Vectors: the vehicle for cloning** | **8** |
| | 5 | Ideal features of a vector | |
| | 6 | Various types of cloning vectors:<br>Plasmid cloning vectors- pBR322, pUC18, and pUC19; Expression vectors- pET vector<br>Bacteriophage cloning vectors – λ phage cloning vectors, M13 phage-based vector<br>Combination vectors- Phagmid and Cosmid vectors | |

| | | | |
|---|---|---|---|
| | 7 | Artificial Chromosomes:<br>Bacterial artificial chromosome vectors (BACs), Yeast artificial chromosome vectors (YACs)<br>Applications of BAC and YAC | |
| | 8 | Shuttle vectors for animals (Adenoviral, Retroviral vectors) and plants (Caulimo viral, TMV vectors), Mammalian vectors for gene therapy | |
| **III** | **rDNA- Construction and Screening** | | **12** |
| | 9 | Construction of recombinant DNA; host cells, competent cells, bacterial transformation - methods | |
| | 10 | Screening methods of transformed cells & recombinants<br>Insertional inactivation, Blue-white screening, antibiotic screening, colony hybridization, colony PCR, Immunological methods | |
| | 11 | DNA libraries: genomic DNA libraries and cDNA libraries-construction & applications | |
| | 12 | Various methods of genetic transformation in eukaryotic cells-Direct gene transfer and vector mediated gene transfer | |
| **IV** | **Techniques for genome analysis and applications** | | **10** |
| | 13 | Molecular hybridization techniques: RFLP, AFLP, RAPD, Southern hybridization | |
| | 14 | PCR: Principle, types(Real time, RT) and applications | |
| | 15 | DNA sequencing: Principle and applications, Genome sequencing methods- Maxam-Gilbert method, Sangers sequencing, NGS. Human genome project | |
| | 16 | Gene expression analysis – Northern hybridization, Micro array | |
| **V** | **Biosafety and ethics in Genetic engineering** | | **9** |
| | 17 | Impact of transgenic organisms in agriculture, medicine, and environment | |
| | 18 | Bioethics: issues with genome modification-case study examples: terminator seeds, environmental impact | |
| | 19 | HGP-ELSI | |
| | 20 | BSL categories for ensuring appropriate containment for rDNA laboratories | |

**Practicals- (30 Hours)-[Essential Experiments (15 Hours), Group/Individual Experiments (15 Hours)]**

**Essential Experiments**

1. Preparation of the reagents for rDNA experiments
2. Purification of Plasmid from bacterial Cultures
3. Estimation of plasmid DNA by UV-VIS spectrophotometer
4. Restriction Digestion of pUC 18 and band analysis by agarose gel electrophoresis
5. Ligation of DNA using ligase
6. *E. coli* Competent cell preparation & Transformation with pUC 18 and selection of ampicillin resistant clones
7. Extraction and purification of Genomic DNA from various sources
8. Quantification of DNA using diphenyl amine method

9. Problem solving assignments
10. Virtual lab on recombinant DNA experiments
11. Research lab visit

**Suggested Reading**


1. Molecular Biotechnology, 1st Edition (2016) - Dehlinger CA, Jones & Bartlett Learning
2. Principles of gene Manipulation, 7th Edition (2013) - Primrose SB, Twyman RM, Wiley Blackwell sciences
3. Molecular Biotechnology, Principles and Applications of recombinant DNA, 4th Edition (2010)- Glick BR, Pasternak J J and Pattern CL, ASM Press, Washington D
4. Gene Cloning & DNA Analysis an Introduction, 7th Edition (2016) – Brown TA, Wiley Blackwell publishers
5. Introduction to Genetic Engineering & Biotechnology, 1st Edition (2010) - Nair, A. J., Jones & Bartlett Publishers, Inc
6. Modern concept of Biotechnology, 1st Edition (1998) - H D Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.
7. Biotechnology, B. Sc. Edition (2016) – Singh BB, Kalyani Publishers, New Delhi


## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand the basic tools required to conduct genetic engineering. | R, U | PSO-1,2 |
| CO-2 | Familiarise to the modern tools and techniques for manipulation and analysis of genomic sequences. | U, Ap | PSO1,PSO3 |
| CO-3 | Understand the Biosafety and ethics concerns connected with genetic engineering. | U, An | PSO5 |
| CO-4 | Design a genetic engineering experiment, selecting appropriate tools | Ap, C | PSO3 |
| CO-5 | Apply rDNA technology in Biotechnological research | Ap | PSO3,PSO4 |
| CO-6 | Handle vectors, enzymes and host cells to conduct rDNA experiments | Ap | PSO3 |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

*Note: 1 or 2 COs/module*

**Name of the Course: Recombinant DNA Technology Credits: 2:1:2**

**(Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand the basic tools required to conduct genetic engineering | PSO1, PSO 2<br>PO-1, PO-2 | R, U | F, C | L | |
| CO-2 | Familiarise to the modern tools and techniques for manipulation and analysis of genomic sequences | PSO -1, PSO-3<br>PO-1, PO-6 | U, Ap | C, P | L | P |
| CO-3 | Understand the Biosafety and ethics concerns | PSO5<br>PO -8 | U, An | F,C | L | |
| | connected with genetic engineering | | | | | |
| CO-4 | Design a genetic engineering experiment, selecting appropriate tools | PSO3<br>PO-3 | Ap, Cr | P, M | - | P |
| CO-5 | Apply rDNA technology in Biotechnological research | PSO3,PSO-4<br>PO-3, PO-6 | Ap | P, M | - | P |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO-6 | Handle vectors, enzymes and host cells to conduct rDNA experiments | PSO3<br><br>PO-6 | Ap | P, M | - | P |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | - | - | - | - | 3 | 2 | | | | | | |
| CO 2 | 3 | - | 2 | - | - | - | 2 | | | | | 3 | | |
| CO 3 | - | - | - | - | 3 | - | | | | | | | | 3 |
| CO 4 | - | - | 2 | - | - | - | | | 3 | | | | | |
| CO 5 | - | - | 3 | 2 | - | - | | | 2 | | | 3 | | |
| CO 6 | - | - | 3 | - | - | - | | | | | | 3 | | |

Correlation Levels:

| Level | Correlation |
|---|---|
| - | Nil |

| | |
|---|---|
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Mapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | ✓ | ✓ | ✓ |
| CO 5 | | ✓ | ✓ | ✓ |
| CO 6 | | | ✓ | ✓ |

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK5DSCBIT301 | | | | |
| Course Title | FOOD AND INDUSTRIAL BIOTECHNOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | V | | | | |
| Academic Level | 300 - 399 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 1 | - | 4 |
| Pre-requisites | Basic of Microbiology | | | | |
| Course Summary | This course encompasses an interdisciplinary field that integrates principles of biology, chemistry, engineering, and technology to develop innovative solutions for the food technology and industrial process. This course deals with various aspects of biotechnological applications in industrial production of microbial products, food production, preservation, and quality enhancement | | | | |

Detailed Syllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Introduction to Industrial Biotechnology** | | 8 |
| | 1 | History and scope of Industrial Biotechnology | |
| | 2 | Biotechnology industries in India | |
| | 3 | Industrial Microorganisms: Screening, Selection, characterization, and strain improvement for industrial applications | |
| II | **Bioreactors, Upstream and Downstream processing** | | 15 |
| | 4 | Bioreactor Design and Operation: Principles of bioreactor design, types of bioreactors, and parameters influencing bioprocesses | |

| | | | |
|---|---|---|---|
| | | Fermentation Technology: Optimization of fermentation processes and scale-up strategies | |
| | 5 | Upstream Processing: Media for fermentation, characteristics of ideal production media, media sterilization, aeration, pH, temperature<br>Bioprocess Monitoring and Control: Techniques for monitoring cell growth, product formation, and controlling bioreactor conditions<br>Batch fermentation, Continuous fermentation, Chemostaticcultures | |
| | 6 | Downstream processing: Downstream processing and product recovery, Different physical and chemical methods for the separation of fermentation products | |
| III | **Industrial production of biomolecules** | | 13 |
| | 7 | Production of therapeutic proteins, antibodies, and vaccines – General strategy<br>Microbial production of antibiotics-Penicillin, vitamins- B12, amino acids- Glutamic acid; Organic acid-Citric acid; Beverages-beer; solvents- butanol | |
| | 8 | Agricultural waste and food industry wastes as the substrate for fermentation, solid state fermentation; production of single cell proteins, microbial production of enzymes- protease and amylase; Immobilization of cells and enzymes-applications | |
| IV | **Food Biotechnology** | | 12 |
| | 9 | Microbial contamination and foodborne pathogens, food borne infections and ,intoxications<br>Biotechnological approaches for enhancing food quality and safety-detection of pathogens, toxins, and allergens | |
| | 10 | Microbial cultures and starter cultures in food fermentation | |
| | 11 | Food preservation- principles of preservation of foods,<br>Role of biopreservation -Role of lactic acid bacteria, bacteriocins, and probiotics in preservation<br>Biocontrol mechanisms and applications- Hurdle Technology-competitive microflora, bacteriocins, and enzymatic inhibitors<br>Genetic approaches to enhance microbial preservation | |
| | 12 | Microbs in food industry- Dairy Biotechnology- dairy products, Industrial process of cheese making, spoilage, milk borne diseases<br>Definition and classification of functional foods | |
| V | **Case Studies and Industry Perspectives** | | 12 |
| | 13 | Concepts and examples of Functional foods, and Nutraceuticals | |
| | 14 | Case studies on Production of bioactive components , highlighting successful applications of industrial biotechnology | |
| | 15 | Visit to different industries | |

**Suggested Reading**


1. Food Microbiology, 2nd Edition (2002) - Adamas MR and Moss MO; Panima Publishing Corporation, New Delhi.
2. Fermentation technology, 3rd Edition (2016) - Stanbury P F, Whitaker A, Hall S J, Butterworth-Heinemann
3. Food Microbiology, 5th Edition (2017) - Frazier WC, Dennis C. Westhoff and N.M. Vanitha, McGraw Hill Education
4. Microbiology, 8th Edition (2011) - Prescott L. M., Harley, J. P., and Klein D. A. Mc Graw Hill, New York
5. Industrial Microbiology, 2nd Edition (2022) – Patel A H, Laxmi Publications
6. Food Processing: Biotechnological Applications, Reprint Edition 2015 - Marwaha SS and Arora JK, Asiatech Publishers Inc., New Delhi
7. Modern concept of Biotechnology, 1st Edition (1998) - H D Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.
8. Industrial microbiology, 2nd Edition (2019) - Casida L E, New Age International Private Limited


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Describe the selection of industrially important microbes for production of biomolecules for human welfare | U | PSO-1,2 |
| CO-2 | Design a controlled environment for microbes for optimum growth and production | R, U, C | PSO-3 |
| CO3 | Evaluate various methods for recovery and purification of bioproduct after fermentation | U, E | PSO-3, PSO-5 |
| CO4 | Aware about application of industrial biotechnology in various field of biotechnology such as fermented food production | U | PSO-1 |
| CO5 | Identify biotechnology industries in India and its opportunities | An | PSO-5 |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

*Note: 1 or 2 COs/module*

**Name of the Course: Food and Industrial Biotechnology Credits: 3:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Describe the selection of industrially important microbes for production of biomolecules for human welfare | PSO-1, PSO-2<br><br>PO-1, PO-2 | U | F, C | L | - |
| CO-2 | Design a controlled environment for microbes for optimum growth and production | PSO-3<br><br>PO-3 | R, U, C | | L | |
| CO3 | Evaluate various methods for recovery and purification of bioproduct after fermentation | PSO-3, PSO-5<br><br>PO-2 | U, E | | L | |
| CO4 | Aware about application of industrial biotechnology in various field of biotechnology such as fermented food production | PSO-1<br><br>PO-1 | U | F | L | - |
| CO5 | Identify biotechnology industries in India and its opportunities | PSO-5<br><br>PO-6 | An | M | L | |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | - | - | - | - | 3 | 2 | | | | |
| CO 2 | - | - | 3 | - | - | - | | | 2 | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 3 | - | - | 3 | - | 2 | - | | 2 | | | | |
| CO 4 | 3 | - | - | - | - | - | 3 | | | | | |
| CO5 | | | | | 2 | | | | | | | 1 |

Correlation Levels:

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO5 | ✓ | ✓ | | |

Uuniversity of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK5DSCBIT302 | | | | |
| Course Title | IMMUNOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | V | | | | |
| Academic Level | 300 - 399. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 | 1 | - | 4 |
| Pre-requisites | Basic knowledge in Cell Biology and Molecular Biology | | | | |
| Course Summary | This course deals with the complex mechanisms of the immune system, exploring both fundamental principles and application level topics in immunology. Through a combination of lectures, discussions, and activities, students will gain a comprehensive understanding of the cellular and molecular components of the immune system, their roles in host defense, and their dysregulation in disease states. | | | | |

Detailed Syllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Introduction to Immunology** | 12 |
| | 1 | Historical perspective and development of basic concepts in immunology | |
| | 2 | Immune system and immunity<br>Organs and cells of the human immune system - Structure and role in immunity | |
| | 3 | Types of immunity: Innate and specific or acquired immunity; Humoral immunity and cell mediated immunity | |
| | 4 | Major Histocompatibility complex- types and functions | |
| | 5 | Innate immune receptors: Toll-like receptors, cytokines, chemokines ,inflammasome research (case study) | |
| | 6 | Complement- Properties and activation pathways, Classical, Lectin & Alternative pathway | |
| II | | **Antigen and Antibody** | 12 |

| | | | |
|---|---|---|---|
| | 7 | Antigens, immunogens, haptens, Adjuvants | |
| | 8 | Immunoglobulins- structure and types of Immunoglobulins Isotypes, allotypes and idiotypes | |
| | 9 | Genetic basis of antibody diversity, Clonal proliferation theory | |
| | 10 | Antibody-antigen interaction: Affinity, Avidity<br>Antigen-antibody reactions - Agglutination, Precipitation, ABO blood grouping, RH incompatibility | |
| III | **Immuno-techniques, Applications and therapeutics** | | 12 |
| | 11 | Immuno-diffusion, immuno-electrophoresis, ELISA, RIA | |
| | 12 | Production of polyclonal and monoclonal antibodies - Hybridoma technology | |
| | 13 | Antibodies in targeting therapeutic agents- therapeutic antibodies | |
| | 14 | Immunity to infections of diseases, Vaccination, Vaccines - Types of vaccines, CAR-T cell therapy | |
| IV | **Autoimmune diseases and Hypersensitivity Reactions** | | 12 |
| | 15 | Autoimmunity and Autoimmune diseases – Organ specific and Systemic; Mechanisms involved in the development of autoimmune disorders - Hashimoto's thyroiditis; Myasthenia gravis; Rheumatoid Arthritis, Pernicious anemia, | |
| | 16 | Hypersensitivity reactions: Types, Asthma | |
| V | **Experimental Immunology and Transplantation immunology** | | 12 |
| | 17 | Experimental immunology: Knock out mice, inbred strains | |
| | 18 | Transplantation, Different types of transplants, Stem cell transplantation<br>Transplant rejection: Mechanism and stages of rejection<br>Transplant rejection therapies - Immunosuppressive drugs, Recent advances | |
| | 19 | Host-pathogen interactions,Immune evasion strategies of pathogens | |

**Suggested Readings**


1. Kuby Immunology, 8th Edition (2018) - Jenni Punt, Sharon Stranford, Patricia Jones, and Judith A Owen, WH Freeman
2. Roitt's Essential Immunology, 13th Edition (2017) – Martin SJ, Burton DR, Roitt IM, and Delves PJ, Wiley-Blackwell
3. Cellular and Molecular Immunology, 10th Edition (2021) – Abbas AK, Lichtman AH, and Pillai S, Elsevier
4. Clinical Immunology, 2022- Rezaei N, Academic Press, Elsevier
5. An Introduction to Immunology, 3rd Edition (2016) – C V Rao, Narosa Publishing House, New Delhi
6. Basics of Biotechnology, 1st Edition (2004) - A J Nair; Laxmi Publications, New Delhi
7. Immunology, 5th Edition (2007) – Joshi, Osama; Agrobios India, New Delhi

Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand how immune system functions and various cells and organs involved in generating immune functions in the body | R,U | PSO-1 |
| CO-2 | Explain how antibody specificity and diversity generated and its significance in immune functions | R, U | PSO1 |
| CO3 | Identify antibody as a tool in immune system and understand antibody mediated immunological detection methods and therapeutic achievements | U,An,Ev | PSO3 |
| CO4 | Discuss how autoimmunity develops in the body and risk factors associated with immunological disorders | Ev | PSO3, PSO-1 |
| CO5 | Critically analyse and make reports on immunological experiments | Ev | PSO-4 |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create
*Note: 1 or 2 COs/module*

**Name of the Course: I mmunology, Credits: 3:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO1 | Understand how immune system functions and various cells and organs involved in generating immune functions in the body | PSO-1 PO-1 | R,U | F, C | L | - |
| CO2 | Explain how antibody specificity and diversity generated and its | PSO-1 PO-1 | R, U | | L | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| | significance in immune functions | | | | | |
| CO3 | Identify antibody as a tool in immune system and understand antibody mediated immunological detection methods and therapeutic achievements | PSO-3<br><br>PO-2 | U, An | C | L | |
| CO4 | Discuss how autoimmunity develops in the body and risk factors associated with immunological disorders | PSO-1<br><br>PO-1 | Ev | F, C | L | - |
| CO5 | Critically analyse and make reports on immunological experiments | PSO-4<br><br>PO-1 | Ev | F,C,M | L | |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | - | - | - | - | - | 2 | | | | | |
| CO 2 | 2 | | - | - | - | - | 2 | | | | | |
| CO 3 | - | - | 3 | - | - | - | | 2 | - | | | |
| CO 4 | 3 | - | - | - | - | - | 3 | | | | | |
| CO5 | | | | 2 | | | 3 | | | | | |

Correlation Levels:

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | - | ✓ |
| CO 2 | ✓ | ✓ | - | ✓ |
| CO 3 | ✓ | ✓ | - | ✓ |
| CO 4 | ✓ | ✓ | - | ✓ |
| CO 5 | | ✓ | | |

# Discipline Specific Elective courses 300-399, DSE3(P), DSE4

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University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK5DSEBIT302 | | | | |
| Course Title | NANOBIOTECHNOLOGY | | | | |
| Type of Course | DSE | | | | |
| Semester | V | | | | |
| Academic Level | 300 - 399 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 hours | 1 | 2 | 5 |
| Pre-requisites | essentials of biotechnology<br>chemistry for life sciences, biomolecules | | | | |
| Course Summary | This elective course provides basic overview of nanomaterials and their applications. This course begins with an overview of development of nanobiotechnology as a scientific stream. Subsequently the course covers synthesis methodologies, physical and chemical characterization of nanomaterials. Application of nanomaterials in diverse fields are elaborated further in this course which will provide the student a strong foundation in this rapidly progressing field, whose active areas are all highlighted. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | **Introduction to nanoworld** | **9** |
| | 1 | History and Development:<br>Lycurgus cup (dichroic glass.), Islamic world Luster, Renaissance pottery, Faraday's Ruby Gold, STM, Feynman's concept, Progress of nanotechnology in various streams of science. | |
| | 2 | Classification of Nanomaterials–<br>Based on spatial confinement: 0D, 1D, 2D & 3D<br>Based on structural composition : Organic, Inorganic, Carbon-based &Composite | |
| | 3 | Properties of nanoparticles:<br>a. Physical, structural and chemical properties<br>b. Mechanical, optical, electromagnetic and biological properties | |
| | 4 | Effect of size and shape of nanoparticles : high surface area to volume ratio Surface functionalization | |

| | | | |
|---|---|---|---|
| **II** | **synthesis and characterization of nanoparticles** | | **10** |
| | 5 | Synthesis of Nanomaterials:- Top Down & Bottom Upapproaches | |
| | 6 | Methods of synthesis - Physical, Chemical &Biological (Plant and Microbes) | |
| | 7 | Characterization of Nanomaterials: UV-VIS SPEC, XRD, FTIR, EM (TEM, SEM) | |
| | 8 | Toxicity evaluation of Nanomaterials – Cytotoxicity and Genotoxicity assays | |
| **III** | **Applications** I | | **10** |
| | 9 | Agriculture: Nanopesticides and Nanofertilizers, Nano-biostimulants and soil enhancers, Nano-enabled technologies for abiotic stress management | |
| | 10 | Environmental– Air, Soil &Water Purification, Contamination detection and Remediation. Nanosensors – applications of nanobiosensors: molecular recognition elements, transducing elements | |
| | 11 | Food processing and preservation– Detection of food pathogens, Chemicals, Pesticides, Toxins, Adulterants and Residual veterinary antibiotics. Quality Monitoring of vitamin components in food. | |
| | 12 | Food packaging- Biodegradable food packaging- Polysaccharides, Proteins, Synthetic polymers, Antimicrobial active packaging, smart and intelligent packaging (labels). | |
| **IV** | **Applications - II** | | **7** |
| | 13 | Medical nanotechnology : Nano systems in medical diagnosis, sensing and imaging | |
| | 14 | Nanoparticles in drug targeting and drug delivery | |
| | 15 | Nanotechnology in therapy (Hyperthermia, Nano vectors in gene therapy, Cancer therapy and Photodynamic therapy) | |
| | 16 | Nanomaterials for biomedical implants, Nano-scaffold in tissue engineering, Nanomaterials as antimicrobials, Recent advances – Nanobots, Nanoflares, Nanoinformatics | |
| **V** | **Challenges, ethics and future** | | **9** |
| | 17 | Toxicity of nanomaterials and possible environmental hazards | |
| | 18 | Regulatory acts and ethical issues (SEI) in the use of nanomaterials | |
| | 19 | Nanobiotechnology as an emerging interdisciplinary research avenue | |
| | 20 | Scope and future potential of Nanobiotechnology | |

**Practicals-30 hours –Essential experiments-15 hours, Group/Individual work-15 hour**

**Essential experiments**

1. Synthesize nanoparticles using various methods such as chemical reduction, sol-gel, or biological synthesis.

2. Characterize the synthesized nanoparticles using techniques like UV-Vis spectroscopy, Dynamic Light Scattering (DLS), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), and Fourier Transform Infrared Spectroscopy (FTIR).

3. Functionalize nanoparticles with biomolecules such as proteins, DNA, or antibodies for specific applications.

4. Characterize the functionalized nanoparticles to confirm successful attachment of biomolecules using techniques like FTIR, UV-Vis spectroscopy, and zeta potential measurements.

5. Assess the toxicity of nanoparticles using in vitro methods

6. Investigate the use of nanomaterials for environmental remediation purposes, such as water purification or pollutant degradation**.**

**Suggested Reading**


1. Nanomaterials – An introduction to synthesis, properties and applications, D. Vollath, Wiley VCH, Second Edition 2013.
2. Nanostructures and Nanomaterials – Synthesis, Properties and Applications, G. Cao, Imperial College Press 2006.
3. Nanostructured materials: Processing, Properties and Potential Applications, Edited by Carl. C. Koch, Noyes Publications, 2002.
4. Bionanotechnology, Lesson from Nature– David S Goodsell, Wiley - Liss, 2004
5. Nanobiotechnology: Concepts,Applications and Perspectives – C M Niemeyer and C A Mirkin, 2004
6. Introduction to Bionanotechnology - Young-Chul Lee , Ju-Young Moon, Springer Link, 2020
7. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|

| | | | |
|---|---|---|---|
| CO-1 | Understand the nanoscale functionalities of materials | R, U | PSO-1,2 |
| CO-2 | Understand the classification and characterisation of nanomaterials | R, U | PSO1 |
| C0-3 | Understand the various applications of nanomaterials | U, An | PSO3 |
| C0-4 | Understand the different ways to use nanotechnology in medicine | U, An | PSO1 |
| CO-5 | Critically analyse the ethics principles based on case studiebsespecially nanobugs gray goo theorem | U, An, E | PSO1 |
| CO-6 | Prepare a case study report on the applications of nanotechnology in agriculture | An, Ap | PSO3,4 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Nanobiotechnology, Credits: 2:1:2(Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| 1 | Understand the nanoscale functionalities of materials | PSO-1,2 | R, U | F, C | L | |
| 2 | Understand the classification and characterisation of nanomaterials | PSO1 | R, U | C, P | L | |
| 3 | Understand the various applications of nanomaterials | PSO3 | U, An | F,C | L | |
| 4 | Understand the different ways to use nanotechnology in medicine | PSO1 | U | F,C | L | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | Critically analyse the ethics principles based on case studies especially nanobugsgray goo theorem | PSO1 | U, An | F,C | L | |
| 6 | Prepare a case study report on the applications of nanotechnology in agriculture | PSO3,4 | An, Ap | C, P | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 1 | - | - | - | - | - | 1 | | | | | | | |
| **CO 2** | 2 | 3 | - | - | - | - | 2 | | | | | | | |
| **CO 3** | - | - | 1 | - | - | - | 1 | | | | | | | |
| **CO 4** | - | - | 2 | 3 | - | - | 1 | | | | | | | |
| **CO 5** | - | 1 | - | - | - | - | 1 | | | | | | | |
| **CO 6** | - | - | - | 3 | - | - | 3 | | | | | | | 2 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | | | ✓ |
| CO 5 | | | | ✓ |
| CO 6 | ✓ | | | ✓ |

# Skill enhancement Courses 300-399

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University of Kerala

| | |
|---|---|
| Discipline | BIOTECHNOLOGY |
| Course Code | UK5SECBIT301 |

| | | | | | |
|---|---|---|---|---|---|
| Course Title | ENTREPRENEURSHIP IN BIOTECHNOLOGY | | | | |
| Type of Course | SEC | | | | |
| Semester | V | | | | |
| Academic Level | 300 - 399 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 3 | 2 | 1 | | 3 |
| Pre-requisites | essentials of Biotechnology, | | | | |
| Course Summary | This graduate-level course offers a comprehensive exploration of the intersection between biotechnology and entrepreneurship. It is designed to equip students with the knowledge, skills, and mindset necessary to navigate the complex landscape of starting and managing biotech ventures. The course delves into various aspects of entrepreneurship within the biotechnology industry, including innovation, business models, financing, regulatory considerations, and ethical implications | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to entrepreneurship** | | **9** |
| | 1 | Introduction to Entrepreneurship, characteristics of an entrepreneurship, types of entrepreneurships | |
| | 2 | Bio-entrepreneurship-concept and significance, objectives of bioentrepreneurship development, Strategy, and operations of bio-sector firms. | |
| | 3 | Promotion of entrepreneurship, Factors influencing entrepreneurship. | |
| **II** | **Development skills for bioentrepreneurship** | | **9** |
| | 4 | Entrepreneurial skills types - team work and leadership skills, analytical and problem-solving skills, critical thinking skills, branding, marketing, and networking skills. | |
| | 5 | Features of a successful Bioentrepreneurship, essential bioentrepreneurial characteristics. | |
| | 6 | Startu ps- Definition and types. Role of entrepreneurship development programmes (EDP). | |

| | | | |
|---|---|---|---|
| **III** | **Bioentrepreneurship development & marketing** | | **9** |
| | 7 | Business plan preparation including statutory and legal requirements, feasibility study and sensing the right business opportunity. | |
| | 8 | Organizational structure & Management, Capital management, novel product innovation technology and development | |
| | 9 | Concept of a Product - Product mix decisions, Brand Decision. | |
| | 10 | Marketing concepts, marketing process, social media for marketing, Marketing Research, and Importance of survey. | |
| **IV** | **Scope of bioentrepreneurship** | | **9** |
| | 11 | Scope of Bioentrepreneurship in Agriculture, Food and Dairy, Biomedical and healthcare (Molecular diagnostics), biological data analysis and Management. | |
| | 12 | Scope of Bioentrepreneurship in Environmental Biotechnology (Biofertilizer, Biofuels, Biological waste management and waste water treatment) and Industrial biotechnology. | |
| | 13 | Funding agencies for entrepreneurship in Biotechnology. Regulations for biotech products. | |
| **V** | **Bioentrepreneurship challenges** | | **9** |
| | 14 | Qualities and functions of Entrepreneurs, Use of IT & AI for business administration, Marketing, and management. | |
| | 15 | Various schemes promoting Bioentrepreneurship. Intellectual Property ,Regulatory and ethical challenges. | |
| | 16 | Industry Visits, Case Studies in Biotech Entrepreneurship, Developing a Biotech Business Plan and presentation and Feedback Sessions | |

**Suggested Reading.**


1. David H Holt. Entrepreneurship: New Venture Creation. Pearson publications.
2. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand &Sons.
3. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge, Routledge Studies in Innovation,
4. Organizations and Technology (2018) Alberto Onetti, & Zucchella, A, CRC press, Taylor and Francis group.
5. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Craig Shimasaki, Academic Press, Elsevier.
6. The Dynamics of Entrepreneurial Development and Management. Vasant Desai, Himalaya Pub. House, ISBN: 9350244543.


**Online Resources**

Authentic web-based resources like NCBI, PubMed, e-pgpathshala, ScienceDirect etc.

**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive | PSO addressed |
|---|---|---|---|

| | | Level | |
|---|---|---|---|
| CO-1 | Explain entrepreneurship,bioentrepreneurship and its significance. | U, E | PSO5 |
| CO-2 | List out the skills required for the bioentrepreneurship. | An | PSO1,5 |
| CO-3 | Summarize the bioentrepreneurship development process and marketing strategies. | U | PSO5 |
| CO-4 | Discuss the Entrepreneurship scope in biological areas. | C | PSO5 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Entrepreneurship in biotechnology Credits: 2:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Explain entrepreneurship | PSO5 | U, E | F, C | L | |
| CO-2 | List out the skills for the bioentrepreneurship. | PSO1,5 | An | P | L | P |
| CO-3 | Summarize the bioentrepreneurship development process | PSO5 | U | F | L | P |
| CO-4 | Discuss the Entrepreneurship scope | PSO5 | C | F | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | - | - | - | - | 3 | - | | | | | | |
| **CO 2** | 1 | - | - | - | 3 | - | | | | | | |
| **CO 3** | - | - | - | - | 3 | - | | | | | | |
| **CO 4** | - | - | - | - | 3 | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

## Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |

# *SEMESTER 6*

**Discipline Specific Core Level 300-399-**
**A9(P),A10,A11**

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK6DSCBIT304 | | | | |
| Course Title | ANIMAL BIOTECHNOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | VI | | | | |
| Academic Level | 300 - 399. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 1 | - | 4 |
| Pre-requisites | Basic knowledge in Molecular biology, and rDNA technology | | | | |
| Course Summary | This course deals with the application of biotechnological tools and techniques for the advancement of animal science, agriculture, and human welfare. This interdisciplinary field integrates principles from rDNA technology, molecular biology and reproductive biology to address various challenges and opportunities related to animal health, productivity, and sustainability | | | | |

Detailed Syllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Introduction to Animal cell culture** | 12 |
| | 1 | Animal cell culture: History | |
| | 2 | Animal cell culture techniques, Primary cell cultures and secondary cell cultures, sub culture techniques<br>Cell lines, Immortalized cell lines, transformed cell lines, Cell strains | |
| | 3 | Finite and continuous cell lines, Anchorage dependent and anchorage independent cells<br>Characterization of cell lines | |
| II | | **Animal Cell Culture - Requirements & Scale up** | 12 |
| | 4 | Basic requirements in animal cell culture lab- instruments and equipment | |
| | 5 | Media - Media components and physical parameters, Growth factors promoting proliferation of animal cell cultures | |

| | | | |
|---|---|---|---|
| | | Principles of sterile techniques, Maintenance of animal cell culture, Cryopreservation, and transport of animal cell cultures<br>Cell viability assays | |
| | 6 | Scale Up- Monolayer cultures and Suspension cultures, roller bottles and spinner flasks, Micro carrier attached growth.<br>Bioreactors for large scale cultivation of animal cells | |
| III | **Gene transfer techniques & Stem cell technology** | | 12 |
| | 7 | Gene transfer techniques- Direct methods, Indirect methods- Animal viral vectors | |
| | 8 | Transgenesis-Transgenic animals and its practical uses- Animals as Bioreactors | |
| | 9 | Stem cell technology: Types of stem cells, Stem cell culture and its clinical uses, Tissue engineered grafts | |
| | 10 | Gene therapy | |
| IV | **Application of Animal Cell Cultures** | | 12 |
| | 11 | Products of animal cell cultures- hormones (Insulin, growth hormones), interferon, t-plasminogen activator, factor VIII, Factor IX | |
| | 12 | Production of vaccines in animal cells | |
| | 13 | Virus cultivation in animal cell cultures | |
| | 14 | Production of polyclonal and monoclonal antibodies-hybridoma technology | |
| V | **Bioethics and Biosafety** | | 12 |
| | 15 | Ethical issues and concerns in Trasgenics<br><br>Ethical use of animals in research - Justification for using animals, Considerations in selection of animal models, Alternatives to animal experimentation such as in vitro models, computer simulations etc. | |
| | 16 | Laboratory safety practices – importance of following standard operating procedures (SOPs) and safety protocols in animal cell culture laboratories, Personal protective equipment (PPE) requirements for researchers working with animal cells, Risk assessments to identify potential hazards, Mitigation strategies | |

**Suggested Readings**


1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications - 7th Edition (2016) - Freshney R I, Wiley-Blackwell
2. Animal Cell Culture: A Practical Approach, 3rd Edition (2000) - Masters J, OUP Oxford
3. Biotechnology-Fundamentals and Application, 3rd Edition (2002) - S S Purohit and S K Mathur, Agrobios, India.
4. Introduction to Genetic Engineering & Biotechnology (2010) - A J Nair, Jones & Bartlett Publishers, Boston, USA.
5. Modern concept of Biotechnology (1998) - H D Kumar; Vikas Publishing House Pvt. Ltd., New Delhi.

6. Biotechnology, 5th Edition (2009) - Smith JE, Cambridge University Press
7. Biotechnology (2015) - B D Singh, Kalyani Publishers

Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand the basic techniques involved in animal cell culture, characteristics, and maintenance of cell lines | U | PSO-1,2 |
| CO-2 | Explain the techniques involved in animal cell cloning and gene transfer methods | U, E | PSO3 |
| CO3 | Elaborate the applications of animal cell culture at various field | Ap | PSO1, PSO4 |
| CO4 | Discuss the problems associated with animal biotechnology and ethical issues | Ev | PSO2,5 |
| CO5 | Explain the basic requirements for the design of an animal cell culture laboratory | U | PSO-1 |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

*Note: 1 or 2 COs/module*

Name of the Course: Animal biotechnology Credits: 3:1:0 (Lecture:Tutorial:Practical)

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand the basic techniques involved in animal cell culture, characteristics, and maintenance of cell lines | PSO1,2 PO1 | U | F, C | L | |
| CO-2 | Explain the techniques involved in animal cell | PSO 3 PO2 | An | F,C | L | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | cloning and gene transfer methods | | | | | |
| CO3 | Elaborate the applications of animal cell culture at various field | PSO1,4<br>PO3 | R,U | F | L | - |
| CO4 | Discuss the problems associated with animal biotechnology and ethical issues | PSO2,5<br>PO8 | U | F, C, M | L | - |
| CO5 | Explain the basic requirements for the design of an animal cell culture laboratory | PSO-1<br>PO-1 | U | F, C | L | |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 1 | - | - | - | - | 2 | - | - | - | - | - | - | - |
| CO 2 | - | - | 3 | - | - | - | - | 2 | - | - | - | - | - | - |
| CO 3 | 1 | - | - | 3 | - | - | - | - | 2 | - | - | - | - | - |
| CO 4 | - | 2 | - | - | 3 | - | - | - | - | - | - | - | - | 3 |
| CO 5 | 3 | - | - | - | - | - | 2 | - | - | - | - | - | - | - |

Correlation Levels:

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | ✓ | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO5 | ✓ | ✓ | | ✓ |

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK6DSCBIT305 | | | | |
| Course Title | PLANT BIOTECHNOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | VI | | | | |
| Academic Level | 300 –399 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 hours | 1 | 2 hours | 5 |
| Pre-requisites | Cell biology, plant physiology, molecular biology, rDNA technololgy | | | | |
| Course Summary | This graduate-level course in Plant Biotechnology provides an in-depth exploration of the principles, techniques, and applications of biotechnology in the context of plant science. The course encompasses a blend of theoretical knowledge, laboratory practical sessions, and discussions on recent advancements in the field. | | | | |

Detailed Syllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Introduction to Plant Tissue Culture** | 6 |
| | 1 | Introduction to plant tissue culture: Basics of Plant Tissue Culture/Micropropagation, Importance of plant tissue culture, Basic set up of a plant tissue culture lab. | |
| | 2 | Fundamental principles of *in vitro* plant cultures: Major Tools and Instrumentation, Selection of explant, familiarization, and use ofplant growth regulators<br>Composition of tissue culture media- media components and its functions, various types of commercially available media.<br>Sterilization Methods-Steam sterilization, Dry sterilization, Filter sterilization, surface sterilization of explants | |
| II | | ***Invitro* Cultures- Types &Applications** | 10 |
| | 3 | Types of *in vitro* cultures: Callus cultures, cell suspension cultures, organ cultures-root cultures, hairy root cultures, embryo cultures | |
| | 4 | Embryogenesis and organogenesis a brief understanding<br>Clonal multiplication and micropropagation- meristem culture, axillary bud and shoot tip culture<br>Anther and pollen culture- production of haploids and its uses | |
| | 5 | Plant secondary metabolites production through cell, tissue and organ cultures, Advantages, and disadvantages of in vitro methods | |

| | | | |
|---|---|---|---|
| III | **Somaclonal Variation and Somatic Hybridization** | | 10 |

| | | | |
|---|---|---|---|
| | 6 | Somaclonal Variation: Possible reasons for somaclonal variations, Selection of soma clones. Applications of somaclonal variations in agriculture and Horticulture, Merits, and demerits of somaclonal variation | |
| | 7 | Protoplast-isolation and culturing of protoplast-principle and application, Regeneration of protoplasts, protoplast fusion and somatic hybridization-selection of hybrid cells | |
| IV | **Genetic engineering and Transgenic plants** | | 10 |
| | 8 | Methods of gene transfer in plants–Physical, chemical, and biological methods (Agrobacterium mediated and Virus mediated) | |
| | 9 | Transgenic crops, Impact of transgenic plants in agriculture and Horticulture, Non-Agricultural applications of transgenic plants-Biopharming-production of therapeutic proteins in transgenic plants, edible vaccines, disease resistant, salt tolerant, pest resistant and stress tolerant crops | |
| | 10 | Metabolic engineering of plants for enhanced and controlled production of plant products | |
| V | **Recent advances and Ethical concerns in Plant Biotechnology** | | 9 |
| | 11 | RNA Interference (RNAi) targeted gene regulation, CRISPR/Cas9 and other genome editing techniques for precise genetic modifications, Synthetic Biology approaches in plant engineering | |
| | 12 | Ethical Concerns : Transgene Containment, Loss of Diversity, Sterile Seed technology | |

**Practical (30Hrs)-[Essential Experiments (15Hrs),**
**Group/Individual Experiments (15 Hrs)]**

**Essential Experiments**

1. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media.
2. Preparation of MS Media
3. Surface sterilization of plant materials for inoculation (implantation in the medium)
4. Development of callus cultures and its sub-culturing
5. Organogenesis-shoot regeneration, root regeneration, somatic embryogenesis
6. Micropropagation of potato/tomato/-Demonstration
7. Familiarization of instruments and special equipment's used in the plant tissue culture experiments- Laminar Airflow chamber,
8. Protoplast isolation and culturing–Demonstration

**Suggested readings**


1. Plant Biotechnology-Recent Advances (2000), P C Trivedi, Panima Publishing Corporation, New Delhi.
2. Introduction to Plant Biotechnology (2020), H S Chawla, Oxford & IBH publishing Co. Pvt. Ltd, New Delhi.

3. Basics of Biotechnology (2004), A J Nair; Laxmi Publications, New Delhi.
4. An Introduction to Plant Tissue Culture (2016), M K Razdan, Oxford &IBH Publishing Co. Pvt. Ltd., New Delhi
5. Role of Biotechnology in Medicinal and aromatic plants (2011), Irfan A Khan and Atiya Khanum, Ukaaz Publications, Hyderabad.
6. Plant Cell, Tissue, and Organ Culture-Fundamental Methods (2004) O L Gamborg, G C Phillips Narosa Publishing House, New Delhi.

**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand fundamentals of plant tissue culture and its tools | U | PSO-1 |
| CO-2 | Evaluate how plant tissue culture techniques is useful in research and agriculture | R, U | PSO3,PSO4 |
| CO3 | To understand genetic variation mechanisms and to evaluate its applications in agriculture | U, Ap | PSO-1 |
| CO4 | Evaluate how to improve the quality of plants through genetic engineering methods | E, Ap | PSO1,3 |
| CO5 | Understand the application of transgenic plants in various fields and awareness about basic ethical concerns related to it | U,AP | PSO2, 3 |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

*Note: 1 or 2 COs/module*

**Name of the Course: Plant biotechnology Credits: 2:1:2 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand fundamentals of plant tissue culture and its tools | PSO1, 2<br>PO 1 | U | F, C | L | P |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO-2 | Evaluate how plant tissue culture techniques is useful in research and agriculture | PSO1, 4<br>PO1, 3 | R, U | P | L | P |
| CO3 | To understand genetic variation mechanisms and to evaluate its applications in agriculture | PSO1,4<br>PO3 | U, Ap | P, M | L | |
| CO4 | Evaluate how to improve the quality of plants through genetic engineering methods | PSO2, 3<br>PO 1,3 | E, Ap | P, M | L | P |
| CO5 | Understand the application of transgenic plants in various fields and awareness about basic ethical concerns related to it | PSO3,5<br>PO 6 | U | C | L | - |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 1 | - | - | - | - | 2 | - | - | - | - | - | - | - |
| CO 2 | 2 | - | - | 2 | - | - | 2 | - | 1 | - | - | - | - | - |
| CO 3 | 2 | - | - | 2 | - | - | - | - | 2 | - | - | - | - | - |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 4 | - | 2 | 2 | - | - | - | 3 | - | 2 | - | - | - | - | - |
| CO 5 | - | - | 2 | - | 2 | - | - | - | - | - | - | 3 | - | - |

Correlation Levels:

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar/Midterm Exam
- Programming Assignments /Final Exam

Mapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | ✓ | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | ✓ | ✓ | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK6DSCBIT306 | | | | |
| Course Title | ENVIRONMENTAL BIOTECHNOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | VI | | | | |
| Academic Level | 300 – 399 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 1 | | 4 |
| Pre-requisites | Basic Biotechnology, Microbiology | | | | |
| Course Summary | Environmental Biotechnology at the graduate level probes deeper into the application of biological principles and processes to address environmental issues and challenges. It encompasses various fields such as microbiology, biochemistry, genetics, and engineering to develop sustainable solutions for environmental conservation, pollution control, and resource management. | | | | |

Detailed Syllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Introduction to Ecosystem and Environment** | 12 |
| | 1 | Environment-Definition, components, and inter-relationships | |
| | 2 | Brief idea on Ecosystems and ecology | |
| | 3 | Ecads and Ecotypes | |
| | 4 | Biodiversity and Biosphere | |
| II | | **Environment Pollution** | 12 |
| | 5 | Pollution: Sources and types<br>General characteristics of domestic wastes, community wastes, agricultural wastes, electronic wastes-effect of solid wastes in the environment | |
| | 6 | Air Pollution: Natural and anthropogenic sources of pollution, Effect of air pollution, Control measures | |
| | 7 | Water pollution: Organic load in aquatic systems, Measuring BOD and COD, Assessing microbial quality of water | |

| | | | |
|---|---|---|---|
| | 8 | Biotechnology and pollution control: Biofiltration and bioreactors for air pollution control<br><br>Monitoring and assessment of water and air quality using biotechnological tools<br>Treatment of municipal wastes and hazardous industrial effluents - aerobic and anaerobic methods, Biofiltration, Biological Scrubbers/ bio trickling filters | |

| | | | |
|---|---|---|---|
| | | Carbon sequestration techniques<br><br>Biotechnological solutions for reducing greenhouse gas emissions | |
| III | **Renewable and Non-renewable Energy** | | 12 |
| | 9 | Renewable and non-renewable energy resources: conventional fuels and their environmental impacts (fire wood, animal oils, coal, petroleum) | |
| | 10 | Non-conventional energy sources<br><br>Biomass: utilization of biomass as energy source– application of microbes in production of fuels from biomass-biogas andmethanogenic bacteria, microbial hydrogen production, production of bioethanol, and other types of chemicals from biomass and agricultural wastes, the gasohol experiment<br>Algal biofuels: cultivation, harvesting, and processing<br><br>Vegetable oils as engine fuels, energy crops-jojoba; Possibility of plant-based petroleum industry and biofuels. | |
| IV | **Bioremediation and Biodegradation** | | 12 |
| | | Microbial diversity and ecosystem functioning, Microbial interactions in natural and engineered environments, Microbial metabolism and nutrient cycling<br><br>Types of pollutants and contaminants<br><br>Bioremediation- strategies: bioaugmentation, biostimulation, phytoremediation, etc.<br><br>Case studies of successful bioremediation projects<br>.<br>Biodegradation - microorganisms used for bioremediation, and applications ,Mechanism of pollutant degradation by microbes | |
| | 11 | .<br>Biological control of pests and insects, Biopesticides- Bacillus thuringiensis, bioherbicides;<br>Application of biotechnology in the production of biofertilizers and nitrogen fixation – nitrogen fixing microorganisms, mycorrhiza | |
| | 12 | Mineral Biotechnology- Enrichment of ores by microorganisms (bioaccumulation and biomineralisation); Bio-assessment of environmental quality | |
| V | **Environment Legislations** | | 12 |

| | | | |
|---|---|---|---|
| | 13 | Environment laws: The Environment Protection act,1986<br>The wildlife preservation act,1982<br>The wildlife protection act,1972<br>The biological diversity act,2002 | |

| | | | |
|---|---|---|---|
| | | The biodiversity Rules,2004<br>National green tribunal act,2010 | |

**Familiarize with the following Techniques**

1. Microbiological assessment of drinking water- water from well, river, water supply department and packaged drinking water
2. Isolation of microbes from the environment- from air, soil, floor of the lab, from water.
3. Assessment of organic load in aquatic systems and factory effluent- Determination of BOD and COD.
4. Biogas production by methanogenic bacteria or by mixed culture in a biogas plant.
5. Isolation of nitrogen fixing bacteria from leguminous plants
6. Determination of NP and K in biofertilizers

**Suggested Readings**


1. Environmental Biotechnology (1999) - Alan H Scragg; Longman, England
2. Biotechnology-Fundamentals and Application (2002) - S S Purohit and S K Mathur; Agrobios, India
3. Biotechnology (2015) - B D Singh, Kalyani Publishers
4. Biological wastewater treatment (1998) - Grady C P L, G T Daigger, H C Lim; CRC Press
5. Environmental Issues and Options (2007) - Mishra C S; Daya Publishing House
6. Biodiversity- Status and Prospects (2005) - Pramod Tandon, Manju Sharma, Renu Swarup; Narosa Publishing House, New Delhi
7. Ecology (2006) - Subrahmanyam N S, A V S S Sambamurty; Alpha Science International Ltd.
8. Biotechnology (2020) - U Satyanarayana, Books and Allied (P) Ltd.
9. Microbiology (2007) - Prescott L. M., Harley, J. P., and Klein D. A; Mc Graw Hill, New York


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand the concept of environment, ecosystem, biodiversity, and biosphere | U | PSO-1,PSO-2 |

| | | | |
|---|---|---|---|
| CO-2 | Identify types and key sources of environmental pollution, and understand various biotechnological control measures for pollution | R, U | PSO 2, PSO- 5 |
| CO3 | Comprehensive understanding on various energy sources and evaluation of strategies for green energy production | U,E | PSO-3, PSO-5 |
| CO4 | Exploiting microbes as a solution for environmental problems as well as energy crisis | U, Ap | PSO3,PSO-5 |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

*Note: 1 or 2 COs/module*

**Name of the Course: Environmental biotechnology Credits: 3:1:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand the concept of environment, ecosystem, biodiversity, and biosphere | PSO-1,2<br>PO 1 | U | F, C | L | - |
| CO-2 | Identify types and key sources of environmental pollution, and understand various biotechnological control measures for pollution. | PSO 2, 5<br>PO 8 | R, U | C, P | L | P |
| CO3 | Comprehensive understanding on various energy sources and evaluation of strategies for green energy production | PSO 3,5<br>PO 6 | U, E | F | L | - |
| CO4 | Exploiting microbes as a solution for environmental problems as well as energy crisis | PSO3,5<br>PO6 | U, Ap | P | L | P |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | - | - | - | - | 3 | - | - | - | - | - | - | - |
| CO 2 | - | 2 | - | - | 3 | - | - | - | - | - | - | - | - | 3 |
| CO 3 | - | - | 2 | - | 2 | - | - | - | - | - | - | 2 | - | - |
| CO 4 | - | - | 2 | - | 3 | - | - | - | - | - | - | 3 | - | - |

Correlation Levels:

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | ✓ | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | ✓ | ✓ |

# Discipline Specific Elective courses 300-399, DSE5(P), DSE6

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|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK6DSEBIT327 | | | | |
| Course Title | CLINICAL RESEARCH AND DATA MANAGEMENT | | | | |
| Type of Course | DSE | | | | |
| Semester | VI | | | | |
| Academic Level | 300 - 399 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 | 1 | 2 | 5 |
| Pre-requisites | basics of Clinical Practices,fundamentals of Clinical Data Management | | | | |
| Course Summary | This course provides an in-depth exploration of the principles and practices of clinical research and data management within the context of healthcare and pharmaceutical industries. It covers the essential components of planning, conducting, and analyzing clinical trials, as well as the management of data generated throughout the research process. Students will gain practical skills in designing protocols, collecting and managing data, ensuring regulatory compliance, and interpreting results. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Clinical Research & Trials** | | **6** |
| | 1 | An overview of clinical Research, clinical trials, study designs and phases of clinical trials, Introduction to biotechnology applications in clinical research | |
| | 2 | Clinical trial protocols, stake holders in clinical trial projects, Serious adverse events. | |
| | 3 | Ethics Committee role in reviewing research proposals and ensuring ethical conduct. | |
| **II** | **Good clinical Practices** | | **10** |
| | 4 | Good Clinical Practices: Comprehending the principles of ICH GCP, including participant protection, data quality and ethical conduct. | |
| | 5 | ICMR guidelines for Biomedical Research on Human Subjects | |
| | 6 | Responsibility of Clinical Research Professionals: (Investigator, Project Manager, Regulatory Affairs Associate, Medical Writer, Clinical Research Associate, Clinical Research Coordinator and Safety Report Associate). | |
| **III** | **Clinical Research Regulations** | | **10** |
| | 7 | Regulation in Clinical Research- Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities | |
| | 8 | Clinical Research Regulatory Submission & approval Process- DCGI submission procedure. | |
| | 9 | Other Regulatory authorities- EMEA, MHRA, PhRMA. | |
| | 10 | An overview of Drug development process and pharmacovigilance | |
| **IV** | **Clinical Data Management** | | **10** |
| | 11 | Data Collection Methods and Instruments - Clinical Trial Design and Protocol Development- Phases of clinical trials,<br>Study design: randomized controlled trials, observational studies, etc.<br>Protocol development and study endpoints, Sample size determination and statistical considerations<br>Clinical data management systems- Electronic data capture, System validation, Test procedures, change control, coding dictionaries, Migrating and archiving Legacy Data. | |
| | 12 | **Clinical Data Management process**- Data management Plan, CRF design considerations, Database design considerations, Study setup, Entering Data, Tracking CRF pages, cleaning data, Managing Lab | |

| | | | |
|---|---|---|---|
| | | Data, Identifying and Managing the discrepancies, Collecting Adverse Event Data, Coding Reported terms, creating report and Transferring data, Closing study. | |
| **V** | **Biostatistics & Pharmacovigilance.** | | **9** |
| | 13 | Regulatory Requirements and Ethical Considerations<br>Data Management and Quality Assurance .Biostatistics in Clinical Studies and Data analysis. | |
| | 14 | Drug development phases, Quality control and quality assurance of clinical research procedures | |
| | 15 | Safety specification and risk management palan, Guidelines in Phamacovigilance. | |

**Practical 30Hours-Essential Experiments-15 hours,Group/Individual work-15 hours**

**Essential Experiments**

1. Design a mock clinical trial for a hypothetical drug or therapy. outline inclusion/exclusion criteria, endpoints, randomization procedures, sample size determination, and ethical considerations.
2. create a detailed protocol including study objectives, study population, intervention, study procedures, and statistical analysis plan.
3. Familiarize with electronic data capture (EDC) systems commonly used in clinical trials. ,enter mock patient data into these systems.
4. design case report forms (CRFs) for data collection, emphasizing the importance of clear and consistent data entry.
5. Provide datasets from past clinical trials and ask students to perform basic statistical analysis using software like R or SPSS

**Suggested Readings**


1. An introduction to clinical research by Piers Page, James Carr, OUP oxford Publication

2. Lawrence MF, Curt DF, David LD (2010) Fundamentals of clinical trials Tom Brody.

3. Clinical Research Principles Practices Perspectives by Mittal and Niti and Bikash Medhi, BSP Books

4. Clinical Trials by Alice Kuruvila, Paras Medical Publisher.

5. Textbook of Clinical Research by Vikas Dhikav AITBS Publishers.

6. Textbook On Clinical Research A Guide for Aspiring Professionals and Professionals by Guru Prasad Mohanta, Pharmamed Press.


Online Resources

Authentic web-based resources like NCBI, PubMed, e-pgpathshala, ScienceDirect etc.

## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Summarize clinical research and phases of clinical trials | U | PSO4 |
| CO-2 | Outline the good clinical practices and explain the drug development process. | U, E | PSO4,5 |
| CO-3 | Categorize the responsibility of clinical research professionals. | A | PSO2 |
| CO-4 | Develop knowledge on basics of clinical data management process and clinical research regulations | A | PSO2 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Clinical research and data management Credits: 3:1:2 (Lecture:Tutorial:)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Summarize clinical research and phases of clinical trials | PSO4 | U | F, C | L | |
| CO-2 | Outline the good clinical practices and explain the drug development process. | PSO4,5 | U, E | P | L | |
| CO-3 | Categorize the responsibility of | PSO2 | A | F | L | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | clinical research professionals. | | | | | |
| CO-4 | Develop knowledge on basics of clinical data management process and clinical research regulations | PSO2 | A | C | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | - | - | - | 2 | - | - | | | | | | |
| **CO 2** | - | - | - | 2 | 2 | - | | | | | | |
| **CO 3** | - | 2 | - | - | - | - | | | | | | |
| **CO 4** | - | 2 | - | - | - | - | | | | | | |

**Correlation Levels:**

| **Level** | **Correlation** |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

## Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments

- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |

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**University of Kerala**

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|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK6DSEBIT328 | | | | |
| Course Title | FORENSIC BIOTECHNOLOGY | | | | |
| Type of Course | DSE | | | | |
| Semester | VI | | | | |
| Academic Level | 300 - 399 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 2 hours | 1 | 2 hours | 5 |
| Pre-requisites | | | | | |

| | |
|---|---|
| Course Summary | Forensic biotechnology is an interdisciplinary field that applies principles of biology, genetics, and technology to analyze evidence in criminal investigations. This graduate-level course covers advanced topics in forensic biotechnology, including DNA analysis, bioinformatics, forensic pathology, and molecular techniques used in crime scene investigation. |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Forensic Biotechnology** | | **6** |
| | 1 | Overview of forensic science and its applications,Historical development and significance of forensic biotechnology<br>Ethics and legal issues in forensic investigations | |
| | 2 | Mendelian inheritance patterns<br>Population genetics and forensic DNA databases | |
| | 3 | Kinship analysis and paternity testing<br>Genetic markers for individual identification | |
| **II** | **DNA Analysis Techniques** | | **10** |
| | 4 | Polymerase chain reaction (PCR) and its applications in forensic DNA analysis<br>Short tandem repeat (STR) analysis and DNA profiling<br>Mitochondrial DNA analysis and its role in forensic identificationy,Y-chromosomal and mitochondrial DNA analysis<br>Next-generation sequencing (NGS) in forensic genomics, Forensic **Epigenetics,Microbial signatures in forensic investigations** | |

| | | | |
|---|---|---|---|
| | 5 | Molecular Techniques in Crime Scene Investigation<br><br>Forensic analysis of biological fluids: blood, saliva, semen, and urine<br>Hair and fiber analysis using molecular techniques<br>Forensic odontology and its role in human identification<br>Case studies and practical applications of molecular techniques in crime scene investigation | |
| | 6 | Comparison of traditional and advanced DNA extraction techniques | |
| | 7 | <br>Mass spectrometry techniques in forensic proteomics<br>Protein profiling for identification and characterization, bioterrorism detection | |
| **III** | **Bioinformatics in Forensic Investigations** | | **10** |
| | 8 | Introduction to bioinformatics tools and databases<br>Sequence alignment and analysis for forensic DNA identification<br>Computational methods for forensic DNA profiling and ancestry inference | |
| | 9 | Principles and applications of Next generation sequencing in forensic genetics | |

| | | | |
|---|---|---|---|
| | | Targeted sequencing vs. whole-genome sequencing<br>Data analysis and interpretation in forensic NGS,: Forensic DNA Profiling Techniques | |
| **IV** | **Forensic Pathology and Serology** | | **10** |
| | 10 | Understanding the role of forensic pathology in criminal investigations<br>Postmortem changes and estimation of time since death<br>Bloodstain pattern analysis and serological techniques<br>Forensic entomology and its application in estimating time of death | |
| | 11 | Advanced Topics in Forensic Biotechnology<br><br>Forensic DNA databases and their role in criminal investigations<br>Emerging technologies in forensic biotechnology: single-cell analysis, microfluidics, and nanotechnology<br>Forensic epigenetics: DNA methylation analysis for forensic applications<br>Ethical considerations and controversies in forensic biotechnology research | |
| **V** | **Emerging Trends and Technologies in Forensic Molecular Biology** | | **9** |
| | 12 | CRISPR-based forensic applications,Nanotechnology in forensic analysis | |
| | 13 | Ethical implications and future directions in forensic molecular biology | |
| | 14 | Analytical techniques for detecting drugs and poisons | |
| | 15 | Insect evidence in crime scene analysis | |

**Practicals-30 hours, Essential Experiments-15 hours, Individual /Group work-15 Hours**

**Essential Experiments**

1. Introduce students to bioinformatics tools and databases for analyzing DNA sequences.
2. analyze DNA sequences and compare them to reference sequences in databases.
3. Explore the use of computational methods for predicting phenotype from genotype (e.g., eye color, ancestry).
4. Perform microbial identification using techniques like 16S rRNA gene sequencing or DNA fingerprinting methods.
5. Prepare simulated biological samples (e.g., blood, urine) spiked with common drugs or toxins.
6. Use techniques like High-Performance Liquid Chromatography (HPLC) or Gas Chromatography-Mass Spectrometry (GC-MS) to detect and quantify the substances present.

**Suggested Reading**


1. Butler, J. M. (2015). Forensic DNA typing: Biology, technology, and genetics of STR markers (2nd ed.). Academic Press.
2. Carracedo, A., & Schneider, P. M. (Eds.). (2009). Forensic DNA profiling protocols. Humana Press.
3. Budowle, B., Schutzer, S. E., Breeze, R. G., & Keim, P. (2005). Microbial forensics. Academic Press.
4. Goodwin, W., & Linacre, A. (2019). Forensic DNA analysis: A laboratory manual. Academic Press.
5. Houck, M. M., & Siegel, J. A. (Eds.). (2010). Fundamentals of forensic science (2nd ed.). Academic Press.
6. Primrose, S. B. (2001). Forensic science: An introduction to scientific and investigative techniques (2nd ed.). CRC Press.


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO1 | Demonstrate a comprehensive understanding of the principles and techniques used in forensic biotechnology. | U | PSO-1 |
| CO2 | Apply advanced molecular techniques for DNA analysis and interpretation of forensic evidence | R, U | PSO-1,3 |
| CO3 | Evaluate bioinformatics tools and databases for forensic DNA profiling and analysis. | U,Ap | PSO-3,4 |

| | | | |
|---|---|---|---|
| CO4 | Analyze and interpret forensic pathology findings in criminal investigations | U, An | PSO-3,4 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Forensic biotechnology Credits: 2:1:2 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/ PSO | Cognitive Level | Knowledge Category | Lecture (L) /Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO1 | Demonstrate a comprehensive understanding of the principles and techniques used in forensic biotechnology. | PSO-1 | U | F, | L | |
| CO2 | Apply advanced molecular techniques for DNA analysis and interpretation of forensic evidence | PSO-1,3 | R, U | P | L | |
| CO3 | Evaluate bioinformatics tools and databases for forensic DNA profiling and analysis. | PSO-3,4 | U,Ap | F | L | |
| | Analyze and interpret forensic pathology findings in criminal investigations | PSO-3,4 | U, An | C | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 1 | - | - | - | - | - | | | | | | |
| **CO 2** | 2 | 3 | - | - | - | - | | | | | | |
| **CO 3** | - | - | 1 | - | - | - | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 4** | - | - | 2 | 3 | - | - | | | | | | |
| **CO 5** | - | 1 | - | - | - | - | | | | | | |
| **CO 6** | - | - | - | 3 | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

## Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

# Skill Enhancement Courses

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| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK6DSCBIT303 | | | | |
| Course Title | CLINICAL RESEARCH AND DATA MANAGEMENT | | | | |
| Type of Course | SEC | | | | |
| Semester | VI | | | | |
| Academic Level | 300 - 399. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 3 | 2 | 1 | | 3 |
| Pre-requisites | basics of Clinical Practices, fundamentals of Clinical Data Management | | | | |
| Course Summary | This course provides an in-depth exploration of the principles and practices of clinical research and data management within the context of healthcare and pharmaceutical industries. It covers the essential components of planning, conducting, and analyzing clinical trials, as well as the management of data generated throughout the research process. Students will gain practical skills in designing protocols, collecting and managing data, ensuring regulatory compliance, and interpreting results. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Introduction to Clinical Research & Trials** | **9** |
| | 1 | An overview of clinical Research, clinical trials, study designs and phases of clinical trials, Introduction to biotechnology applications in clinical research | |
| | 2 | Clinical trial protocols, stake holders in clinical trial projects, Serious adverse events. | |
| | 3 | Ethics Committee role in reviewing research proposals and ensuring ethical conduct. | |
| II | | **Good clinical Practices** | **9** |
| | 4 | Good Clinical Practices: Comprehending the principles of ICH GCP, including participant protection, data quality and ethical conduct. | |
| | 5 | ICMR guidelines for Biomedical Research on Human Subjects | |
| | 6 | Responsibility of Clinical Research Professionals: (Investigator, Project Manager, Regulatory Affairs Associate, Medical Writer, Clinical Research Associate, Clinical Research Coordinator and Safety Report Associate). | |
| III | | **Clinical Research Regulations** | **9** |
| | 7 | Regulation in Clinical Research- Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities | |
| | 8 | Clinical Research Regulatory Submission & approval Process- DCGI submission procedure. | |

| | | | |
|---|---|---|---|
| | 9 | Other Regulatory authorities- EMEA, MHRA, PhRMA. | |
| | 10 | An overview of Drug development process and pharmacovigilance | |
| **IV** | **Clinical Data Management** | | **9** |
| | 11 | Data Collection Methods and Instruments - Clinical Trial Design and Protocol Development- Phases of clinical trials,<br>Study design: randomized controlled trials, observational studies, etc.<br>Protocol development and study endpoints, Sample size determination and statistical considerations<br>Clinical data management systems- Electronic data capture, System validation, Test procedures, change control, coding dictionaries, Migrating and archiving Legacy Data. | |
| | 12 | **Clinical Data Management process**- Data management Plan, CRF design considerations, Database design considerations, Study setup, Entering Data, Tracking CRF pages, cleaning data, Managing Lab Data, Identifying and Managing the discrepancies, Collecting | |

| | | | |
|---|---|---|---|
| | | Adverse Event Data, Coding Reported terms, creating report and Transferring data, Closing study. | |
| **V** | **Biostatistics & Pharmacovigilance.** | | **9** |
| | 13 | Regulatory Requirements and Ethical Considerations<br>Data Management and Quality Assurance .Biostatistics in Clinical Studies and Data analysis. | |
| | 14 | Drug development phases, Quality control and quality assurance of clinical research procedures | |
| | 15 | Safety specification and risk management palan, Guidelines in Phamacovigilance. | |

**Suggested Readings**


1.An introduction to clinical research by Piers Page, James Carr, OUP oxford Publication

2.Lawrence MF, Curt DF, David LD (2010) Fundamentals of clinical trials Tom Brody.

3. Clinical Research Principles Practices Perspectives by Mittal and Niti and Bikash Medhi, BSP Books

4. Clinical Trials by Alice Kuruvila, Paras Medical Publisher.

5. Textbook of Clinical Research by Vikas Dhikav AITBS Publishers.

6. Textbook On Clinical Research A Guide for Aspiring Professionals and Professionals by Guru Prasad Mohanta, Pharmamed Press.


Online Resources

Authentic web-based resources like NCBI, PubMed, e-pgpathshala, ScienceDirect etc.

## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Summarize clinical research and phases of clinical trials | U | PSO4 |
| CO-2 | Outline the good clinical practices and explain the drug development process. | U, E | PSO4,5 |
| CO-3 | Categorize the responsibility of clinical research professionals. | A | PSO2 |
| CO-4 | Develop knowledge on basics of clinical data management process and clinical research regulations | A | PSO2 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course:** Clinical research and data management **Credits: 2:1:0 (Lecture:Tutorial:)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Summarize clinical research and phases of clinical trials | PSO4 | U | F, C | L | |
| CO-2 | Outline the good clinical practices and explain the drug development process. | PSO4,5 | U, E | P | L | |
| CO-3 | Categorize the responsibility of clinical research professionals. | PSO2 | A | F | L | |
| CO-4 | Develop knowledge on basics of clinical data management process and clinical research regulations | PSO2 | A | C | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | - | - | - | 2 | - | - | | | | | | |
| **CO 2** | - | - | - | 2 | 2 | - | | | | | | |
| **CO 3** | - | 2 | - | - | - | - | | | | | | |
| **CO 4** | - | 2 | - | - | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

## Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |