**Scheme and Syllabus**

**For**

**Learning Outcome Based Curriculum Framework**

**(LOCF)**

**For**

**B.Sc. Biotechnology (Honours)**

**(Undergraduate Programme)**

**(To be implemented from session 2021-2022)**

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**Department of Biotechnology**

**Guru Ghasidas Vishwavidyalaya**

**Bilaspur, Chhattisgarh, India – 495009**

1. **Introduction of B.Sc. (Hons) Biotechnology Programme**

Creativity is the rule of nature based on innovative thoughts. Biotechnology has the potential to combine the knowledge of basic biology of the natural diversity and innovative technologies to create or evolve novel processes or novel products beneficial for human welfare. Biotechnology has emerged as the most important vehicle for solving the problem of health, food and agricultural issues. The need for qualified human resource for various biotechnology based industries is the driving force to design and implement B.Sc. program in Biotechnology. A sound knowledge of biotechnology is thought to play an important role in the upcoming years to encourage the modern biology driven developmental efforts. There is a need for qualified and competent students with sound knowledge of Biotechnology in general and specialized technology such as recombinant DNA technology, fermentation technology, bioinformatics, cell and tissue culture, etc in particular. The Department of biotechnology offers the B.Sc. (Biotechnology) course with an outcome based curriculum emphasizing the Critical, Analytical and Problem Solving skills to equip the students to pursue their academic, scientific and research career with better preparedness and matured professional outlook. The presence of other allied Faculties of the University provides additional exposure to students the multi-disciplinary approach which is emerging as a key differentiator in the success of modern biology and biotechnology based endeavours. The overall purpose of the course is to impart quality education in the field of biotechnology and to create trained biotechnologist. The curriculum of the BSc Biotechnology programme is based on learning outcome based approach. Extensive deliberation has been made to identify the minimum learning outcome from a student after completing each course.

**2. Learning Outcome-based Curriculum Framework in B.Sc. Biotechnology Programme**

B.Sc. Biotechnology is a six-semester course spread over the period of three years. The learning outcomes-based curriculum framework for a B. Sc (Honours) degree in Biotechnology is designed to offer in depth knowledge of the biotechnology starting from its basic concepts of biotechnology to the state of art technologies used in molecular biology, recombinant DNA technology, microbial technology, animal and plant tissue culture and genomics. Students are also provided extensive laboratory training on the course content and the current requirements of industries as well as research and development sectors. In the final semester every student has to undertake a dissertation project, which is essential for strengthening the hands on skill and analytical thinking in designing and solving a problem relevant to modern biology. In addition the course caters to the requirements of providing exposure to NET/SET syllabus for Life Sciences.

* 1. **Nature and Extent of the Programme in B.Sc. (Hons) Biotechnology**

The course is designed as per the UGC regulation for a period of three years where the students have to study 14 Core courses in Biotechnology, 4 advance courses in Biotechnology known as Discipline Specific Elective Courses, 4 Generic Elective Courses to which the students will study in other departments, 2 Skill Enhancement Elective Courses and 5 Ability Enhancement Compulsory Courses. Generic Elective Courses will be opted by the students depending on their choice in other departments as per the courses available in other departments of the university. In first four semesters the students are provided basics of Biotechnology, besides the courses which they have to opt in other departments. In V and VI semester hard core Biotechnology discipline specific courses are included.

* 1. **Aims of Bachelor Degree Programme in B.Sc. (Hons) Biotechnology**

The overall objective of the Bachelors (Honours) Programme in Biotechnology is to enable students to learn and integrate knowledge in different aspect of biotechnology such as genetics, molecular biology, biochemistry, immunology and techniques that is relevant to study and understand the complex biological processes and thus prepare them for post-graduate education and careers in research, medicine and industry. The goal is to equip students with appropriate tools of analysis and with theoretical, technical and analytical skills to tackle issues and problems in the field of biotechnology. The programme aims to

* + - Provide students with learning experiences that help to develop deep interests in learning Biotechnology; to develop an understanding of the complex nature of biomolecules, their inter-relationship and inter-dependence and techniques to study them.
    - Encourage students to apply the knowledge and skills they have acquired to develop solutions for various applications of Biotechnology in human health care and agriculture.
    - Provide students with the knowledge and skill base that would enable them to undertake further studies in Biotechnology and related areas or in multidisciplinary areas that involve Biotechnology and help develop a range of generic skills that are relevant to pursue research, self-employment and entrepreneurship.

**3. Overview of the Department**

There are 9 full-time well qualified experienced faculty having expertise in various fields of biotechnology such as, Microbiology, Immunology, Molecular Biology, Biochemistry, Genetic Engineering, Industrial Biotechnology, Bioinformatics, Plant and Animal cell culture, etc. The department has well equipped laboratories with sophisticated instruments such as **a**utoclave, BOD Incubators, Hot Air Oven, Bacteriological Incubators, Microscopes, Inverted Microscope, Laminar Air Flow, Growth chamber, Biosafety cabinet, CO2 Incubator, Cryo storage, Water Bath Shaker, Deep Freezer, Spectrophotometer, Vertical and Horizontal Slab Gel System, 2D gel electrophoresis system, UV Transilluminator, pH Meter, Centrifuge, Water distillation unit, Small scale fermenter, Deep Freezer and GC MS. etc. Every year the department organizes various workshops, seminar, guest lectures in subject specific domains to enrich our students with recent developments in the field of Biotechnology. We invite Alumni of the department every year to orient the present students with the scope in the field of Biotechnology and share their experiences about their career progression. Over the years, after completion of B.Sc. Biotechnology course our students pursue higher education from our department as well as from various premier institution of India and abroad.

**3. Graduate Attributes in B.Sc. (Hons) Biotechnology**

A graduate in the B.Sc. (Hons) in Biotechnology programme is expected to demonstrate the following attributes

* + **Disciplinary knowledge and skills:** Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, principles and applications of different areas of biotechnology such as Molecular Biology, Recombinant DNA technology, Bioinformatics, Microbiology, Immunology, Plant and Animal Biotechnology and Environmental Biotechnology (ii) ability to use modern instrumentation/techniques for separation, purification and identification of biologically important molecules and its application in human welfare.
  + **Skilled communicator:** Ability to convey complex technical information relating to Biotechnology in a clear and concise manner both in writing as well as orally.
  + **Critical thinker and problem solver:** Ability to employ critical thinking and efficient problem solving skills in different areas related to Biotechnology like Protein and Nucleic Acid Chemistry, Cell Biology, Molecular Biology, Genetics, Microbiology, Animal Biotechnology, Plant Biotechnology and Bioprocess engineering.
  + **Sense of inquiry:** Capability for raising relevant questions relating to basic understanding and applications in the field of Biotechnology and planning, executing and reporting the results of an experiment or investigation.
  + **Team player/worker:** Capable of working effectively in diverse teams in both classroom, laboratory as well as in field-based situations.
  + **Digitally literate:** Capable of using computers for simulation and computational work and appropriate software for analysis of data, and employing modern library search tools to locate, retrieve, and evaluate biology-related information.
  + **Ethical awareness/reasoning:** Avoiding unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, and sensitive towards environmental and sustainability issues.
  + **Lifelong learners:** Capable of making conscious efforts to achieve self-paced and self- directed learning aimed at personal development and for improving knowledge and developing skill.

**4. Qualification Descriptors for Graduates B.Sc. (Hons) Biotechnology**

The qualification descriptors for B.Sc. (Hons) programme in Biotechnology includes the following:

* + A student should demonstrate (i) a comprehensive and coherent understanding of the field of Biotechnology and its applications and links to related disciplinary areas of study; (ii) practical knowledge that enables different types of professions related to Biotechnology, including research and development, teaching, entrepreneurship as well as industrial research abilities; (iii) skills in areas pertaining to current developments in the academic field of study, including a critical understanding of the latest developments in the field of Biotechnology and an ability to use established techniques of analysis.
  + Demonstrate comprehensive knowledge about materials, including current research, scholarly and professional literature, relating to essential and advanced learning areas pertaining to Biotechnology, and techniques and skills required for identifying life science related problems and issues.
  + Demonstration of skills in collection of relevant data gathered by reading or experimentation and analysis and interpretation of the data using appropriate methodologies.
  + Ability to communicate the results of studies undertaken in an academic field accurately in the form of a paper, oral presentation or report.
  + Apply one‟s knowledge and understandings of Biotechnology and skills to new and unfamiliar contexts and to identify and analyze problems and issues and seek solutions to real-life problems.
  + Demonstration of the ability to function in an effective manner both independently as well as a member of a team.

**5. Programme Learning Outcomes for in B.Sc. (Hons) Biotechnology**

The curriculum is designed to achieve the following outcomes:

* To develop an in-depth knowledge and understanding of the fundamental concepts, principles and applications of Biotechnology.
* To impart the procedural knowledge that creates different types of professionals in the field of Biotechnology and related fields such as Molecular Biology, Immunology, Bioprocess engineering, Animal Biotechnology, Plant Biotechnology, Microbiology, Biochemistry and in teaching, research and human welfare.
* Students will be able to undertake hands on laboratory work and activities that help develop in students practical knowledge and skills that are required for pursuing career in clinical diagnosis, drug design, vaccine development, pharmaceutical industry, teaching, research, environmental monitoring.
* Students will be able to use skills required for the extraction, separation, and synthesis of a variety of biomolecules utilized in clinical diagnosis, pharmaceutical industry or in research laboratories.
* Students will be able to use various bioinformatics tools for training in the basic theory and application of programs used for database searching, protein and DNA sequence analysis and prediction of protein structures.
* Students will be encouraged to effectively communicate scientific reasoning and data analysis in both written and oral forms.
* Students will gain knowledge of ethical and good laboratory practices, health and biohazard regulations, plagiarism and intellectual property rights related issues practiced in modern era of scientific investigation.
* Students will recognize and appreciate the importance of the Biotechnology and its application in academics, clinical diagnosis, prevention and treatment of diseases, agriculture, and industry and in the economic, environmental and social contexts.

##### **6. Program Duration, Design and Structure**

**Duration of the Program:** The B.Sc. Honours in Biotechnology is a three-year degree programme divided into six semesters. Each academic year starting from month of July will consist of two semesters.

**Program Design:** The program has been designed to offer a variety of discipline specific and interdisciplinary courses disseminated through class-room, laboratory and out-of-classroom modes of teaching and monitored through a repertoire of assessment methods. The teaching- learning process will include theory classes of one hour duration and practical classes of two hour duration for every credit offered. The curriculum will be delivered through various methods including classical chalk and talk, power-point presentations, essay writing and quiz contests, audio and video tools, e-learning and e-content, virtual labs, field trips or educational tours, seminars by external experts, workshops and symposiums and class discussions and debates. The learning outcome will be assessed by direct and indirect methods comprising broadly of Internal Assessment or Continuous Evaluation and End- Semester Examination. The internal assessment will include mid-term written tests, multiple choice questions, home and class assignments, oral presentations (seminars), group tasks, class discussions and debates, essay and report writing. End-semester assessments will include written tests and practical examinations.

**Structure of the Programme**: The B.Sc. Biotechnology programme is structured into a variety of courses with different credits. Broadly, the programme comprises of Core Courses (C) and elective courses. The core courses are all compulsory courses. The elective courses are of three kinds: Discipline-Specific Elective (DSE), Skill Enhancement Course (SEC) and Generic Elective (GE). The programme also includes Ability Enhancement Courses (AEC). To successfully complete the program, a student must study prescribed and approved number of Core Courses, Generic Electives, Discipline-Specific Electives, Skill Enhancement Courses and Ability Enhancement Courses. A student has to earn a minimum credits as prescribed and approved at university level, to get a degree in B.Sc. (H) Biotechnology.

### Scheme for Choice Based Credit System (CBCS) in B.Sc. Honours Biotechnology

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course** | | **Course Code** | **Name of the course** | **Credit** |
| **Semester-I** | | | | |
| Core (C) | C1Theory | BTUATT1 | Cell Biology | 3 |
| C1 Practical | BTUALT1 | Laboratory-1 based on core-1 | 2 |
| C2 Theory | BTUATT2 | Biochemistry | 3 |
| C2 Practical | BTUALT2 | Laboratory-2 based on core-2 | 2 |
| Generic Elective-1 (GE-1) | GE-1 Theory | BTUATG1 | Bioethics and Biosafety | 3 |
| GE-1 Practical | BTUALG1 | Laboratory-GE1 based on GE-1 | 2 |
| Ability Enhancement Course (AEC) | AEC1 | BTUATA1 | Biotechnology and Human Welfare | 2 |
| Skill Enhancement Course | SEC1 | BTUATL1 | Plant Tissue Culture | 2 |
| Additional Credit Course As per University Notification | | | |  |
| **TOTAL** | | | | **19** |
|  | | | | |
| **Semester-II** | | | | |
| Core (C) | C3 Theory | BTUBTT1 | General Microbiology | 3 |
| C3 Practical | BTUBLT1 | Laboratory-3 (based on core-3) | 2 |
| C4 Theory | BTUBTT2 | Genetics | 3 |
| C4 Practical | BTUBLT2 | Laboratory-4 (based on core-4) | 2 |
| Generic Elective-2 (GE-2) | GE-2 Theory | BTUBTG1 | Biostatistics | 3 |
| GE-2 Practical | BTUBLG1 | Laboratory (based on GE-2) | 2 |
| Ability Enhancement Course (AEC) | AEC2 | BTUBTA1 | Bio-management of environment | 2 |
| Skill Enhancement Course | SEC2 | BTUBTL1 | Animal Tissue Culture | **2** |
| Additional Credit Course As per University Notification | | | |  |
| **Total** | | | | **19** |
|  | | | | |
| **Semester-III** | | | | |
| Core (C) | Core5 Theory | BTUCTT1 | Molecular Biology | 3 |
| Core 5 Practical | BTUCLT1 | Laboratory-5 (based on core-5) | 2 |
| Core 6 Theory | BTUCTT2 | Recombinant DNA Technology | 3 |
| Core 6 Practical | BTUCLT2 | Laboratory-6 (based on core-6) | 2 |
| Core 7 Theory | BTUCTT3 | Chemistry-1 | 3 |
| Core 7 Practical | BTUCLT3 | Laboratory-7 (based on core-7) | 2 |
| Generic Elective-3 (GE-3) | GE-3 Theory | BTUCTG1 | Food Biotechnology | 3 |
| GE-3 Practical | BTUCLG1 | Laboratory-GE3 (based on GE-3) | 2 |
| Ability Enhancement Course (AEC) | AEC3 | BTUCTA1 | Intellectual property rights and entrepreneurship | 2 |
| Additional Credit Course As per University Notification | | | |  |
| **Total** | | | | **22** |
|  | | | | |
| **Semester IV** | | | | |
| Core (C) | Core-8 Theory | BTUDTT1 | Bio-analytical Tools | 3 |
| Core -8 Practical | BTUDLT1 | Laboratory-8 based on core-8 | 2 |
| Core -9 Theory | BTUDTT2 | Immunology | 3 |
| Core -9 Practical | BTUDLT2 | Laboratory-9 based on core-9 | 2 |
| Core 10 Theory | BTUDTT3 | Chemistry-2 | 3 |
| Core 10Practical | BTUDLT3 | Laboratory-10 based on core-10 | 2 |
| Generic Elective-4 (GE-4) | GE-4 Theory | BTUDTG1 | Scientific Writing | 3 |
| GE-4 Practical | BTUDLG1 | Laboratory-GE4 based on GE-4 | 2 |
| Ability Enhancement Course (AEC) | AEC4 | BTUDTA1 | Molecular techniques in disease diagnosis | 2 |
| Additional Credit Course As per University Notification | | | |  |
| **TOTAL** | | | | **22** |
|  | | | | |
| **SUMMER Internship: at least 15 days** | |  |  | **06** |
|  | | | | |
| **Semester V** | | | | |
| Core (C) | Core-11Theory | BTUETT1 | Bioprocess Technology | 3 |
| Core11 Practical | BTUELT1 | Laboratory-11 based on core-11 | 2 |
| Core12Theory | BTUETT2 | Plant and Animal Biotechnology | 3 |
| Core12 Practical | BTUELT2 | Laboratory-12 based on core-12 | 2 |
| Discipline Specific Elective (DSE-1) | DSE-1 | BTUETD1 | MOOC courses\* to be selected/opted from SWAYAM portal [from a basket of course approved by BOS from time to time]. | 2-5\* |
| Discipline Specific Elective (DSE-2) | DSE-2 | BTUEED2 | Review writing/case studies | 5 |
| Ability Enhancement Course (AEC) | AEC5 | BTUETA1 | Biotechnology in Societal Welfare | 2 |
| Additional Credit Course As per University Notification | | | |  |
| **TOTAL** | | | | **22\*** |
|  | | | | |
| **Semester VI** | | | | |
| Core (C) | Core13 Theory | BTUFTT1 | Statistics in Biological Research | 3 |
| Core13 Practical | BTUFLT1 | Laboratory-13 based on core-13 | 2 |
| Core14 Theory | BTUFTT2 | Bioinformatics | 3 |
| Core14 Practical | BTUFLT2 | Laboratory-14 based on core-14 | 2 |
| Discipline Specific Elective (DSE-3) | DSE-3 Theory (Any one) | BTUFTD1 | Microbial Technology | 3 |
| BTUFTD2 | Biodiversity and Bio-prospecting |
| BTUFTD3 | Genomics and Proteomics |
| BTUFTD4 | Molecular Diagnostics |
| DSE-3 Practical  (Any one) | BTUFLD1 | Laboratory (based on DSE-3 BTUFTD1) | 2 |
| BTUFLD2 | Laboratory (based on DSE-3 BTUFTD2) |
| BTUFLD3 | Laboratory (based on DSE-3 BTUETD3) |
| BTUFLD4 | Laboratory (based on DSE-3 BTUETD4) |
| Dissertation | Dissertation | BTUFPD1 | Dissertation/project | 7 |
| Seminar | Seminar | BTUFPS1 | Seminar | 2 |
| Additional Credit Course As per University Notification | | | |  |
| **Total** | | | | **24** |

**Course Structure of B.Sc. (Hons) Biotechnology under CBCS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SEMESTER I** | | | **SEMESTER II** | |
| **C1** | Cell Biology | | **C3** | General Microbiology |
| **C2** | Biochemistry | | **C4** | Genetics |
| **GE-1** | Bioethics and Biosafety | | **GE-2** | Biostatistics |
| **AEC1** | Biotechnology and Human Welfare | | **AEC2** | Bio-management of environment |
| **SEC1** | Plant Tissue Culture | | **SEC2** | Animal Tissue Culture |
|  | Additional Credit Course As per University Notification | |  | Additional Credit Course As per University Notification |
| **SEMESTER III** | | | **SEMESTER IV** | |
| **C5** | | Molecular Biology | **C8** | Bio-analytical Tools |
| **C6** | | Recombinant DNA Technology | **C9** | Immunology |
| **C7** | | Chemistry 1 | **C10** | Chemistry-2 |
| **GE-3** | | Food Biotechnology | **GE-4** | Scientific Writing |
| **AEC3** | | Intellectual property rights and entrepreneurship | **AEC4** | Molecular techniques in disease diagnosis |
|  | | Additional Credit Course As per University Notification |  | Additional Credit Course As per University Notification |
| **SEMESTER V** | | | **SEMESTER VI** | |
| **C11** | | Bioprocess Technology | **C13** | Statistics in Biological Research |
| **C12** | | Plant and Animal Biotechnology | **C14** | Bioinformatics |
| **DSE- 1** | | MOOC courses\* to be selected/opted from SWAYAM portal [from a basket of course approved by BOS from time to time] | **DSE-3**  **(Any one)** | Microbial Technology |
| Biodiversity and Bioprospecting |
| Genomics and Proteomics |
| Molecular Diagnostics |
| **DSE-2** | | Review writing/case studies | **DSE-4** | Dissertation/project |
| **AEC5** | | Biotechnology in Societal Welfare |  | Seminar |
|  | | Additional Credit Course As per University Notification |  | Additional Credit Course As per University Notification |

**C**: Core Courses (14); **AEC**: Ability Enhancement Course (05); GE: Generic Elective (04); **SEC**: Skill Enhancement Courses (02); **DSE**: Discipline Specific Elective (04).

***Numbers within bracket indicate the total number of courses to be taken up by the student in each category.***

**B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)**

**Semester – I**

**COURSE: Core -1 Theory**

**Cell Biology (BTUATT1) CREDITS: 3**

**Course Objective**

The objective of the course is to provide a guide in the basic, fundamental and detailed concepts of Cell Biology. This course is to introduce to the students the basic knowledge of cell and cell organelle and their functions, how cell organelles can be separated, how these cells are communicate to each other via cell adhesion molecules. The students also gained the knowledge about the cell cycle and how cells are dividing and biological basis of cancer and about the carcinogenic agents may participate in cancer development. The aim of this subject is to strengthen the knowledge of the candidate desired to work on the basic as well as applied aspects of biology

### Course Learning Outcomes

After successful completion of the course student will be able to understand

* Introduction and classification of organisms by cell structure
* Cell membrane and permeability
* cytoskeleton and cell motility
* Composition of extracellular Matrix
* Cellular organelles
* Cell cycle
* Characteristics and biological basis of cancer

### Course Contents

### Unit-I: Introduction of Cell

### Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cell, cell fractionation types: Differential and density gradient centrifugation. Cell membrane and permeability: chemical components of biological membranes, their organization and fluid mosaic model, membrane as dynamic entity, cell recognition and membrane transport.

### Unit –II: Cytoskeleton and Extracellular Matrix

Membrane vacuolar system, cytoskeleton and cell motility, Structure and function of microtubules, microfilaments, intermediate filaments. Extracellular Matrix: composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, regulation of receptor expression and function.

**Unit –III: Cell organelles and functions**

Structure, biogenesis and functions of endoplasmic reticulum, Golgi complex, Lysosomes, Vacuoles and microbodies, Ribosomes, Mitochondria, chloroplast and nucleus.

**Unit –IV: Cell cycle and cancer**

Cell Cycle, mitosis & meiosis, Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and biological basis of cancer.

**Suggested Reading**

1. Karp, G. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis. E.M.F. Cell and Molecular Biology. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. The cell: A Molecular Approach ASM Press & Sunderland

Washington, D.C.; Sinauer Associates, M A.

4.Becker, w.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell. Pearson

Benjamin Cummings Publishing, San Francisco

**COURSE: Core -1 Practical**

**Laboratory-1 based on core-1 (BTUALT1) CREDITS: 2**

**Course Objective**

The objective of this course is to provide hands on training of experiments of Cell Biology

### Course Learning Outcomes

After successful completion of the course student will be able to perform:

* Experiment showing the effect of temperature and organic solvents on semi permeable membrane.
* Plasmolysis and de-plasmolysis
* Structural observation of prokaryotic cell and eukaryotic cells

**Course contents**

1. To study the effect of temperature and organic solvents on semi permeable membrane.
2. To study the Plasmolysis.
3. To study the de-plasmolysis.
4. To study the structure of Prokaryotic cell (bacteria).
5. To study the structure of Eukaryotic cell (Plant and Animal).

**Suggested Reading**

1. Karp, G. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis. E.M.F. Cell and Molecular Biology. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. The cell: A Molecular Approach ASM Press & Sunderland

Washington, D.C.; Sinauer Associates, M A.

4.Becker, w.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell. Pearson

Benjamin Cummings Publishing, San Francisco

**COURSE: Core -2 Theory**

**Biochemistry (BTUATT2) CREDITS: 3**

**Course objective**

The objective of the course is to make students well-versed with the structure and function of various biomolecules, their metabolic synthesis and catabolism. They should have knowledge of qualitative analysis of different types of biomolecules. The course deals with the basic structure and classification of biomolecules and their metabolic reactions. The course elucidates properties of carbohydrates, proteins, lipids, nucleic acids and enzymes.

### Course Learning Outcomes

After successful completion of course the students will acquire:

* Students will acquire understanding of various biomolecules which are required for development and functioning of a cell.
* Students will learn structural and functional features of carbohydrates and their role inenergy generation and as storage food molecules for the bacterial cells
* The students will be able to understand structure and function of proteins, to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics; also knowledge about lipids and nucleic acids.
* Student will have the ability to prepare buffers, study enzyme kinetics and calculate Vmax, Km, Kcat values.

### Course Contents

**Unit I**

Introduction to Biochemistry: Amino acids & Proteins**:** Structure and properties of Amino acids, Synthesis of aromatic and aliphatic amino acids, amino acid oxidation and production of urea. Types of protein and their classification structure and shape. Different levels of structural organization of proteins (primary, secondary, tertiary and quaternary).

**Unit II**

Structure, classification, functions and properties of carbohydrates Glycolysis, fate of pyruvate under aerobic and anaerobic conditions, Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis, TCA cycle, Electron Transport Chain, Oxidative phosphorylation.

**Unit III**

Structure, classification, functions and properties of fatty acid, Biosynthesis of saturated and unsaturated fatty acids. ß-oxidation of fatty acids. Structure, functions, and properties of DNA, double helical model of DNA structure and forces responsible for A, B & Z – DNA. Structure, functions, and properties of RNA

**Unit IV**

Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric &oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity.

**Suggested Reading**

1. Berg, J. M., Tymoczko, J. L. and Stryer, L Biochemistry. W.H Freeman and Co.

2. Buchanan, B., Gruissem, W. and Jones, R. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.

3. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry, WH Freeman and Company,New York, USA.

4. Hopkins, W.G. and Huner, P.A. Introduction to Plant Physiology. John Wiley and Sons.

5. Salisbury, F.B. and Ross, C.W. Plant Physiology, Wadsworth Publishing Co. Ltd.

**COURSE: Core -2 Practical**

**Laboratory-2 based on core-2 (BTUALT2) CREDITS: 2**

**Course Objective**

The objective of this course is to provide practical exposure to biophysical parameter like pH, molarity and qualitative analysis of biomolecules.

### Course Learning Outcomes

• Student will acquire skills to understand concept of molarity, molality and normality

• Student will acquire skill to prepare different types of buffers.

• Student will acquire skills for qualitative analysis of carbohydrates, proteins and lipids

• Student will acquire skills estimate the concentration of protein in biological samples

**Course contents**

1. To calculate the molarity, molality, normality and their relationship of given sample.
2. To preparethe buffers (acetate and phosphate buffers).
3. To maintain the pH of different types of buffer using pH meter.
4. To study the Qualitative tests for carbohydrates (for reducing and nonreducing sugars), lipids (Zak’s test for cholesterol) and proteins (ninhydrin test, biuret test).
5. To estimate the content of protein by using Lowry method/Bradford method.

**Suggested Reading**

1. Berg, J. M., Tymoczko, J. L. and Stryer, L Biochemistry. W.H Freeman and Co.

2. Buchanan, B., Gruissem, W. and Jones, R. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.

3. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry, WH Freeman and Company,New York, USA.

4. Hopkins, W.G. and Huner, P.A. Introduction to Plant Physiology. John Wiley and Sons.

5. Salisbury, F.B. and Ross, C.W. Plant Physiology, Wadsworth Publishing Co. Ltd.

**COURSE: Generic Elective-1 (GE- 1)**

**Bioethics and Biosafety (BTUATG1) CREDITS: 3**

**Course Objective**

This course aims at introducing the importance of the basic concepts of bioethics and biosafety and their relationship with several fields such as ecology, agriculture, medicine, chemistry and advances brought about in the field of biology and medicine. The course deals with answers to ethical questions that arise in the relationships among life sciences and their importance in the field of biotechnology.

### Course Learning Outcomes

* On the successful completion of the course, students will be able to understand importance of general safety measures in laboratories and biosafety guidelines.
* Justify the design of confinement facilities at different Biosafety levels.
* Implement good laboratory practices.
* Describe the standard operating procedures for disposal of various types of wastes from the Biotechnology laboratory.

**Course contents**

**Unit I**

Bioethics: Necessity of Bioethics, different paradigms of Bioethics: National & International, Universal Declaration on Bioethics and Human Rights, Ethical issues against the molecular technologies.

**Unit II**

Biosafety: Introduction, different levels, applications, protocol (UN Cartagena Biosafety Protocol) and health hazards related to Biotechnology, guidelines of Biosafety in India.

**Unit III**

Introduction to the concept of containment level and Good Manufacturing Practices (GMP), OECED guidelines of Good Laboratory Practices (GLP), Quality assurance programme, apparatus material and reagents used for GLP.

**Unit IV**

Ethical, Legal and Social Implication program of Human Genome project, Bioethics in Biodiversity and recourses management, genetically modified foods: steps for genetically modified food technology regulations, ethical issues and present scenario in consumption of Genetically Modified Organisms.

**Suggested Reading**

1.Sateesh MK Bioethics and Biosafety, I. K. International Pvt Ltd.

2. Sree Krishna V Bioethics and Biosafety in Biotechnology, New age international publishers

**COURSE: Generic Elective-1 (GE- 1) Practical**

**Laboratory (Based on GE-1) (BTUALG1) CREDITS: 2**

**Course Objective**

The objective of this course is to understand the good laboratory processes and practices. This course also helps to understand the health ethics, clinical trial of drug and medical errors.

### Course Learning Outcomes

* Students will be aware of good laboratory processes.
* Have the knowledge of clinical trial of the drug
* Able to understand the medical error and negligence.
* Aware about the women health ethics

**Course contents**

1. To study the guidelines for good laboratory Practice
2. To identify the different hazardous symbols for different chemicals/reagents used in laboratory
3. A case study on clinical trials of drugs in India with emphasis on ethical issues
4. Case study on women health ethics
5. Case study on handling and disposal of radioactive waste
6. Case study on medical errors and negligence

**Suggested Reading**

1. Sateesh MK Bioethics and Biosafety, I. K. International Pvt Ltd.

2. Sree Krishna V Bioethics and Biosafety in Biotechnology, New age international

Publishers

3. Fleming, D.A., Hunt, D.L., Biotechnology and Safety Assessment, Academic press.

4. Thomas, J.A., Fuch, R.L. Biotechnology and safety assessment CRC press, Washington.

patents by Sibley. Butterworth publication

5. Biotechnology - A comprehensive treatise. Legal economic and ethical dimensions VCH.

**COURSE: Ability Enhancement Course - 1 (AEC - 1)**

**Biotechnology and Human Welfare (BTUATA1) CREDITS: 2**

**Course Objective**

The objective of this course is to introduce the scope of biotechnology for human welfare.

### Course Learning Outcomes

Learning outcomes on completion of this course the students will be able to;

* Understand industrial biotechnology related techniques.
* Understand agriculture and environmental biotechnology related techniques.
* Understand forensic science related technique
* Understand molecular diagnosis techniques.

**Course contents**

**Unit I**

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, Enzyme immobilization: methods and application.

**Unit II**

Agriculture and Environments: Plant Tissue culture, N2 fixation, transgenic plants: insect resistance, bacterial/ fungal stress tolerance, drought/salt tolerance, bioremediation, biofertilizers, biopesticides, biofuels and bioleaching.

**Unit III**

Forensic science: solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing, Polymerase chain reaction, Restriction fragment length polymorphism.

**Unit IV**

Health: development of non- toxic therapeutic agents, recombinant live and DNA vaccines, gene therapy, Molecular diagnosis: (monoclonal antibodies, DNA probes, Microarrays), transgenic animals.

**Suggested Reading**

1.Sateesh MK Bioethics and Biosafety, I. K. International Pvt Ltd.

2. Sree Krishna V Bioethics and Biosafety in Biotechnology, New age international publishers

3. Gupta, Elements of Biotechnology

4. Dubey, T. B. of Biotechnology

5. Kumar H. Modern Concept of Biotechnology

6. Jogdand, Advances in Biotechnology

7. Chatwal, T. B. of Biotechnology

8. Primrose, Molecular Biotechnology

**COURSE: Skill Enhancement Course - 1 (SEC-1)**

**Plant Cell Culture (BTUATL1) CREDITS: 2**

**Course Objective**

The course deals with the Plant tissue culture principles and basic techniques. The objective of the course is to make students well-versed with the methods and techniques of plant tissue culture and its application.

**Course Learning Outcomes**

* Students will acquire skills related to plant tissue culture
* Students will acquire skills on plant tissue culture techniques
* Students will acquire skills on Micropropagation
* Students will acquire skills related to In-vitro Fertilization

**Course contents**

**Unit-I (Introduction to Plant Tissue culture)**

Introduction to Plant Tissue culture, Terms and definitions, Historical background, Laboratory organization, Tools and techniques, methods of sterilization. Laboratory contaminants- it’s control and measures.

**Unit-II (Media and Culture Preparation)**

Role of Micro and macro nutrients, Vitamins and carbon source in tissue culture, Media preparation- pH, Temprature, Solidifying agents, Slant Preparations etc. Maintenance of cultures, Environmental Conditions, explants characteristics.

**Unit-III (Culture techniques)**

Explants selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture.

**Unit-IV (Initiation of Cultures)**

Induction and growth parameters; Culture initiation, Callus culture., Micropropagation through various explants

**Unit-V (In-vitro Fertilization)**

Role of Ovary and ovule in In-vitro Fertilization in production of agricultural and horticultural crops. Techniques and significance of Androgensis and Gynogenesis (ovary, ovule, egg, synergids culture)

**Suggested Reading**

1. Bhojwani S.S. And Rajdan M.K. (1983). Plant Tissue Culture : Theory and practice.
2. Reinert J.and Bajaj Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, By Springer - Verlag, Berlin
3. Amritrao, P.V.D.A. Evans, W.P.Sharp and Bajaj Y.P.S. (1990) Handbook of Plant Cell Culture volumes I-V, McGraw Hill Publishing Co.,New York.
4. Chawla, H.S. 2000. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Dixon, R.A. and Gonzales, R. A. (Eds.) 1994. Plant Cell Culture - A Practical Approach. Oxford University Press, New York.
6. Gamborg, O.L and Phillips, G.C. 1998. Plant Cell, Tissue Organ Culture. Narosa Publishing House, NewDelhi.

**Semester – II**

**COURSE: Core -3 Theory**

**General Microbiology (BTUBTT1) CREDITS: 3**

**Course Objective**

* To introduce the concepts of microbiology in a stimulating and explanatory manner
* To aware students about history and scope of microbiology
* To learn the method of cultivation and enumeration of microbes from environment
* To understand the nutritional requirements of micro-organisms
* To understand microbial growth and population kinetics
* To understand mechanism of gene transfer and genetic recombination in bacteria

**Course Learning Outcomes**

After successful completion of the course student will be able to understand

* History and scope of microbiology
* Microbial diversity and microbial taxonomy
* Cultivation and maintenance of microorganisms
* Microbial growth, reproduction and metabolism
* Genetic recombination in bacteria (Transformation, Transduction and Conjugation)
* Harmful and beneficial activities of microbes

**Course Contents**

**Unit I: History and scope of microbiology**

History and scope of microbiology, Microbial taxonomy, Classification of microorganisms: criteria used including molecular and polyphasic approaches, microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization of Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Viruses

**Unit II: Cultivation and maintenance**

Cultivation and maintenance of microorganisms: methods preservation. Nutritional categories of micro-organisms Control of microorganisms by physical, chemical and chemotherapeutic agents.  **Unit III: Microbial growth and metabolisms**

Microbial growth: Growth curve, Generation time, synchronous, batch and continuous culture, methods of measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Asexual reproduction (binary fission, endospores and sporulation in bacteria), Genetic recombination (Transformation, transduction and conjugation).

**Unit IV: General food microbiology**

Bacteria, fungi, algae and cyanobacteria pollutants of water' sewage composition and its disposal, important microorganisms in food: moulds, yeasts, bacteria. Major food born infections and intoxications in humans, food spoilage and preservation of various types of foods.

**Suggested Reading**

1. Alexopoulos C J, Mims CW, and Blackwell M. Introductory Mycology. John and Sons. Inc.

2. Jay JM, Loessner M J and Golden D A. Modern Food Microbiology. CBS Publishers and

Distributors, Delhi, India.

3. Kumar HD. Introductory Phycology. Affiliated East Western Press.

4. Madigan MT, Martinko JM and Parker J. Brock Biology of Microorganisms. Pearson/

Benjamin Cummings.

5. Pelczar M J,Chan E C S and Krieg N R. Microbiology. McGraw Hill Book Company.

6. Stanier RY, Ingraham J L, Wheelis M L, and Painter PR. General Microbiology. McMillan.

7. Tortora GJ, Funke BR, and case CL. Microbiology: An Introduction. Pearson Education.

8. Willey JM, Sherwood LM, and Woolverton cJ' Prescott' Harley and Klein's microbiology McGraw Hill, Higher Education.

**COURSE: Core -3 Practical**

**Laboratory-3 based on core-3 (BTUBLT1) CREDITS: 2**

**Course Objective**

The objective of this course is to provide practical exposure of microbiological techniques and experiments.

**Course Learning Outcomes**

After successful completion of the course student will be able to perform

* Sterilization (autoclave and hot air oven) techniques followed in microbiology laboratory
* Isolation of bacteria from different sources
* Preparation of media for cultivation of bacteria/fungi.
* Biochemical characterization of isolated bacteria.
* Staining of isolated bacteria using different methods (Gram staining, Spore staining, Negative staining).
* Determination of the bacterial cell size by micrometry
* Enumeration of the total & viable cell count of microorganism by using haemocytometer.

**Course contents**

1. To study the methods of sterilization (autoclave and hot air oven).

2. To study the methods of isolation of bacteria from different sources.

3. To prepare the media for cultivation of bacteria/fungi.

4. To perform the biochemical characterization of isolated bacteria.

5. To perform the staining of isolated bacteria using different methods (Gram staining,

Spore staining, Negative staining).

6. To determine the bacterial cell size by micrometry.

7. To enumerate the total & viable cell count of microorganism by using haemocytometer.

**Suggested Reading**

1. Alexopoulos C J, Mims CW, and Blackwell M. Introductory Mycology. John and Sons. Inc.

2. Jay JM, Loessner M J and Golden D A. Modern Food Microbiology. CBS Publishers and

Distributors, Delhi, India.

3. Kumar HD. Introductory Phycology. Affiliated East Western Press.

4. Madigan MT, Martinko JM and Parker J. Brock Biology of Microorganisms. Pearson/

Benjamin Cummings.

5. Pelczar M J,Chan E C S and Krieg N R. Microbiology. McGraw Hill Book Company.

6. Stanier RY, Ingraham J L, Wheelis M L, and Painter PR. General Microbiology. McMillan.

7. Tortora GJ, Funke BR, and case CL. Microbiology: An Introduction. Pearson Education.

8. Willey JM, Sherwood LM, and Woolverton cJ' Prescott' Harley and Klein's microbiology McGraw Hill, Higher Education.

**COURSE: Core -4 Theory**

**Genetics (BTUBTT2) CREDITS: 3**

**Course objective**

The major objective of this course is to develop clear understanding of various aspects of genetics and genomes and enable students to better understand courses taught later such as recombinant DNA technology and other allied papers.

**Course learning outcomes**

On the successful completion of the course, students will be able to:

* Understand the basic principles of Mendelian genetics, Allelic and non-allelic interactions and analyze the inheritance pattern.
* Describe the chromosomal sex-determination mechanisms and dosage compensation.
* Define the eukaryotic genomic organization and differentiate between unique and repetitive DNA.
* Gain knowledge on chromosomal/genetic mutation and different types of syndrome.
* Calculate the gene and allele frequency using Hardy-Weinberg law and analyse population genetics problems

### Course Contents

### Unit I

Mendelian genetics: Mendel’s law, test and back crosses, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, pleiotropy, polygenic inheritance, multiple allele, pseudo-allele, essential and lethal genes. Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive).Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over

**Unit II**

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA. Eukaryotic chromosome: chromosome morphology, concept of euchromatin and heterochromatin, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, genetic code.

**Unit III**

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames tests for mutagenic agents, variations in chromosomes structure, point mutation. Chromosomal aberrations in human beings, abonormalities: Aneuploidy (Down, Turner, Klienfelter syndrome) and Euploidy, non-disjunction.

**Unit IV**

Sex determination and sex linkage: Mechanisms of sex determination, Barr bodies, genetic balance theory, Fragile-X- syndrome and chromosome, sex linked diseases and inheritance, Pedigree analysis. Evolution and population genetics: Hardy Weinberg law, allelic and genotype frequencies.

**Suggested Reading**

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

**COURSE: Core -4 Practical**

**Laboratory-4 based on core-4 (BTUBLT2) CREDITS: 2**

**Course Objective**

On the successful completion of the course, students will be able to solve the problems based on Mendelian genetics using checker board. Differentiate various human traits inherited in a family. Construct and interpret a karyotype prepared from a spread of metaphase chromosomes.

### Course Learning Outcomes

* Understand the basic principles of pedigree analysis and will be able to construct and analyse pedigree related problems for inherited traits.
* Identify barr body in different type of samples.

**Course contents**

1. To study the Mendelian Genetics in monohybrid and dihybrid crosses using checker board
2. To study the human traits
3. To identification of Barr body in human sample.
4. To study the Karyotyping with the help of photographs
5. To analyse the autosomal and sex linked disease using Pedigree charts.
6. To study the polyploidy in onion root tip by colchicine treatment.

**Suggested Reading**

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

**COURSE: Generic Elective-2 (GE- 2)**

**Biostatistics (BTUBTG1) CREDITS: 3**

**Course Objective**

The objective of this course is to provide detailed knowledge of biostatistics. Understanding the concept of statistics is necessary for researchers to test their hypothesis and to analyse their experimental data to make firm conclusions.

### Course Learning Outcomes

After successful completion of the course student will be able to understand

* Scope and applications of biostatistics
* Collection, processing and presentation of data
* Measures of central tendency
* Measures of dispersion
* Correlation analysis and regression analysis
* Testing of hypothesis

**Course Contents**

**Unit I: Scope and Applications of Biostatistics**

Scope and applications of Biostatistics, samples and population concept, collection, processing and presentation of data, frequency distribution

**Unit II: Measures of Central Tendency**

Measures of central tendency: Arithmetic, Harmonic and Geometric Mean, Mode and Median, their applications, merits and demerits

**Unit III: Measures of dispersion**

Measures of dispersion, Variance, Standard Deviation, Coefficient of Variance, their applications, merits and demerits, Correlation analysis and Regression analysis, Concept of Probability

**Unit IV: Test of Significance**

Comparison of two data sets: testing of hypothesis, Student’s t-test, Chi square test, F-test- introduction and application in biology, comparison of three and more data sets: ANOVA test.

**Suggested Reading**

1. Le CT Introductory biostatistics. John Wiley, USA

2. Glaser AN High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA

3. Edmondson A and Druce D Advanced Biology Statistics, Oxford University Press.

4. Danial W Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

5. Mishra BN and Mishra SN, Principles of Biostatistics.

6. Marcello pagano, Principle of Biostatistics.

**COURSE: Generic Elective-2 (GE- 2) Practical**

**Laboratory (Based on GE-2) (BTUBLG1) CREDITS: 2**

**Course Objective**

The objective of this course is to provide hands on training of experiments of biostatistics

**Course Learning Outcomes**

After successful completion of the course student will be able

* To study the data based on graphical representation (Bar, multiple bars, histogram, pie chart etc.)
* To determine the mean, median, mode and standard deviation of given sample/data
* To determine the probability of given sample/data
* To perform the t-test/F-Test of given data
* To perform the Chi-square test of given data

**Course Contents**

1. To study the data based on graphical representation (Bar, multiple bars, histogram, pie chart etc.)
2. To determine the mean, median, mode and standard deviation of given sample/data
3. To determine the probability of given sample/data
4. To perform the t-test/F-Test of given data
5. To perform the Chi-square test of given data

**Suggested Reading**

1. Le CT Introductory biostatistics. John Wiley, USA

2. Glaser AN High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA

3. Edmondson A and Druce D Advanced Biology Statistics, Oxford University Press.

4. Danial W Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

5. Mishra BN and Mishra SN, Principles of Biostatistics.

6. Marcello pagano, Principle of Biostatistics.

**COURSE: Ability Enhancement Course – 2 (AEC - 2)**

**Bio-management of Environment (BTUBTA1) CREDITS: 2**

**Course Objective**

The aim of the course is to study the different techniques such as bioremediation (using microorganisms) and phytoremediation (using plants) techniques which is helpful for the degradation of environmental pollutants such as pesticides, heavy metals, radioactive substances etc. present in the soil, water and aquifers.

**Course Learning Outcomes**

* On the successful completion of the course, students are aware of the biomanagement of soil.
* Have knowledge about biomanagement of petroleum contaminant.
* Aware of the biomanagement of heavy metal.
* Have the knowledge of bioremediation (using microorganisms) and phytoremediation techniques.

**Course contents**

**Unit I**

Biomanagement of soil: An overview of global market and available technologies local gain, global loss: The Environmental cost of action, bioavailability of contaminants in soil,microbial remediation of metals in soils

**Unit II**

Biomanagement of Petroleum Contaminants: benzene-contaminated underground aquifers. Biomining, Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals, Molecular aspects and applications in biotechnology

**Unit III**

Biosurfactants, strategies based on the use of fungal enzymes, anaerobic Metabolism and bioremediation of BTEX Hydrocarbons (Benzene, Toluene, Ethylbenzene, and Xylene), Treatment of municipal waste and Industrial effluents, Bio-fertilizers, Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, Algal and fungal biofertilizers (VAM)

**Unit IV**

Heavy metal phytoremediation: Microbial indicators of soil health for the assessment of remediation efficiency. Environment and the tools in rhizo- and bioremediation of contaminated soil molecular tools for monitoring and validating bioremediation, genetic engineering of bacteria and their potential for bioremediation

**Suggested Reading**

1. S.C. Santra, Environmental Science

2. Pradipta Kumar Mohapatra, Environmental Biotechnology

3. Hans-Joachim Jordening and Jesef Winter, Environmental Biotechnology – Concepts and

Applications

4. Metcalf and Eddy, Tata McGraw hill, Waste Water Engineering

5. S.S. Purohit, Agricultural Biotechnology

6. Alicia L. Ragout De Spencer, John F.T. Spencer, Environmental Microbiology : Methods and Protocols

7. Milton Wainwright, Introduction to Environmental Biotechnology

8. Gilbert Masters, Principles of Environmental Engineering

9. Metcalf & Eddy, Wastewater Engineering

10. Sibley, Law and Strategy of biotechnological patents. Butterworth publication

11. Ganguli-Tat McGrawhill, Intellectual property rights.

12 Wattal, Intellectual Property Right. Oxford Publication

**COURSE: Skill Enhancement Course - 2 (SEC-2)**

**Animal Cell Culture (BTUBTL1) CREDITS: 2**

**Course Objective**

The objective of this course is to provide basic knowledge of animal cell culture. This course is designed to make students aware about techniques of animal cell and tissue culture. This course will also teach how cultured cells can be maintained in animal cell culture laboratory.

**Course Learning Outcomes**

After successful completion of the course

* Student will acquire experimental skill of Cell culture techniques and competence in laboratory techniques.
* Student will develop proficiency in establishing and maintaining of cell lines.
* To conduct the independent research in the animal cel culture and its further application

**Course contents**

**Unit I**

History and scope of animal cell culture technology. Basic requirements of animal cell culture laboratory (Laminar air flow, CO2 incubator, centrifuge, microscope) biological containment and biosafety levels**,** good laboratory practices to prevent contamination, common cell culture contaminants

**Unit II**

Culture media and buffers, natural and defined media, basal media, serum supplemented media, serum free media, growth supplements, balanced salt solution, sterilization and filtration of media.

**Unit III**

Cell culture techniques, primary and secondary culture, cell lines, monolayer culture, suspension culture, organ culture, cryopreservation of cell lines

**Unit IV**

Behaviour of cultured cells in terms of growth, differentiation and metabolism, apoptosis, necrosis and senescence, appearance of viable and non-viable cells, application of cell culture, in-vitro fertilization

**Suggested Reading**

1. Butler, M and Dawson, M. (eds.).: Cell Culture Lab Fax, Eds., Bios Scientific Publications Ltd., Oxford. Clynes, M. (ed).: Animal Cell Culture Techniques. Springer.

2. Sambrook & Russel. Molecular Cloning: A laboratory manual.

3. Freshney, Culture of Animal cell: A mannual of Basic Techniques

4. Masters, J. R. W. (ed): Animal Cell Culture – Practical Approach, Oxford Univ. Press.

5. Basega, R. (ed): Cell Growth and Division: A Practical Approach. IRL Press.

6. Mather, J.P and Barnes, D. (eds). : Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Academic Press.

**Semester-III**

**COURSE: Core -5 Theory**

**Molecular Biology (BTUCTT1) CREDITS: 3**

**Course Objective**

The objective of the course is to introduce to the students the basic knowledge of flow of information in living organism, how DNA is replicated, how genes are transcribed and how the process of translation takes place in prokaryotes and eukaryotes. The students can apply this knowledge in enhancing their analytical and problem solving skills and to develop an interest in the field of molecular biology to pursue research. It will also enable the students to apply the knowledge gained to tackle various challenges in human health care and agriculture.

### Course Learning Outcomes

* + Students will acquire basic knowledge about the structure of DNA, about organization of genome in various life forms and how DNA is replicated in cells.
  + Students will acquire basic knowledge about the process of transcription, RNA processing and translation in prokaryotes and eukaryotes.
  + Students will learn about the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage.
  + Students will learn about the various ways in which these biological processes are regulated and the significance of regulation in maintaining life forms.

### Course Contents

**Unit I: DNA Replication**

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semi-conservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

**Unit II: DNA Damage and Repair**

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, recombination repair. Homologous recombination: models and mechanism, nonhomologous end joining.

**Unit III: Transcription**

Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5’ cap formation, polyadenylation, splicing, rRNA and tRNA splicing

**Unit IV: Translation**

Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Regulation of gene expression in prokaryotes: Lac Operon and eukaryotes: tryptophan eukaryote.

##### **Suggested Reading**

* + 1. Nelson, D.L. and Cox, M.M., (2013). *Lehninger: Principles of Biochemistry*. 6th ed., W.H. Freeman & Company (New York).
    2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., (2008). *Molecular Biology of the Gene.* 6th ed., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York).
    3. Benjamin Lewin; Jocelyn E Krebs; Stephen T Kilpatrick; Elliott S Goldstein (2018). *Lewin's Gene X* , 10th Edition. Bartlett Learning Publishers, LLC.

**COURSE: Core -5 Practical**

**Laboratory-5 based on core-5 (BTUCLT1) CREDITS: 2**

**Course Objective**

* The objective of this course is to provide practical exposure of basic molecular biology techniques to study the DNA and RNA.

### Course Learning Outcomes

* Student will acquire skills to isolate the chromosomal DNA from bacterial cells/plant cells/ animal cells.
* Student will acquire skill to isolate the RNA from bacterial cells/plant cells/ animal cells.
* Student will acquire skills to quantitate genomic DNA & plasmid DNA with the help of Spectrophotometer.
* Student will acquire skills to check the quality of isolated genomic DNA & plasmid DNA, RNA with the help of agarose gel electrophoresis.

**Course contents**

1. To isolate the chromosomal DNA from bacterial cells/plant cells/ animal cells

2. To isolate the Plasmid DNA by alkaline lysis method

3. To quantify the genomic DNA & plasmid DNA with the help of Spectrophotometer ‘

4. To check the quality of isolated genomic DNA & plasmid DNA with the help of Agarose

Gel Electrophoresis.

5. To isolate the RNA from plant cells/ animal cells

6. To quantify the RNA with the help of Spectrophotometer

7. To check the quality of isolated RNA with the help of Agarose gel Electrophoresis.

**Suggested Reading**

1. Karp, G Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology. Lippincott Williams and Wilkins, Philadelphia.

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell. Pearson Benjamin Cummings Publishing, San Francisco.

4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., Molecular Biology of the Gene Cold Spring Harbour Lab. Press, Pearson Pub.

**COURSE: Core -6 Theory**

**Recombinant DNA Technology (BTUETT2) CREDITS: 3**

**Course Objective**

The objective of the course is to knowledge about various tools and techniques available in molecular biology. The course will give basics os how DNA molecules are manipulated in order to clone and express in a different host. This will generate enthuse among the students to use molecular tools to modify/engineer living organisms for the sake of social benefit in various field such as agriculture, pharmaceutical, health, bioprocessing and value addition.

### Course Learning Outcomes

Students who complete this course will be able to

* Learn various molecular tools used for DNA manipulation and analysis of genetic materials.
* Learn techniques and their applications in genetic engineering.
* Understand various types of cloning and expression vectors and their use.
* Learn how recombinant proteins are produced
* Learn how transgenic plants and animals are created.

### Course Contents

**Unit I**

History of recombinant DNA technology, Host controlled restriction modification system, restriction endonucleases, cutting and joining of DNA molecules *in vitro*. Phosphatases, ligases and polymerases. Southern and Northern hybridization, Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription, Genome mapping, Restriction mapping, DNA fingerprinting, Principle applications and types of Polymerase chain reaction (PCR).

**Unit II**

Cloning vectors: plasmid, bacteriophage, cosmids, phagemid, expression vectors, Gene transfer methods: microinjection, electroporation, microprojectile bombardment, shot gun method, ultrasonication, lipofection, micro laser, RNA-interference, selection and screening of recombinants by genetic and immunochemical

**Unit III**

Expression of foreign genes in *E.coli* and Yeast, application of gene cloning for the analysis of gene structure and function, expression of foreign genes using strong promoters, production of protein, artificial insulin gene, recombinant vaccine and other therapeutics from cloned genes

**Unit IV**

Genetic engineering in plants: use of *Agrobacterium tumefaciens* and *Agrobacterium rhizogenes*, Ti plasmids, application of recombinant DNA technology. Genetic engineering in animals: production of transgenic mice, embryonic stem cells for gene targeting in mice, applications of gene targeting.

**Suggested Reading**

1. Brown TA. Gene Cloning and DNA Analysis. Blackwell Publishing, Oxford, U.K.

2. Clark DP and Pazdernik NJ. Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

3. Glick, B.R., Pasternak, J.J. Molecular Biotechnology-Principles and Applications of recombinant DNA. ASM Press, Washington

4. Primrose SB and Twyman RM. Principles of Gene Manipulation and Genomics, Blackwell Publishing, Oxford, U.K.

5. Sambrook J, Fritsch EF and Maniatis T. Molecular Cloning-A Laboratory Manual. Cold Spring Harbor Laboratory Press.

**COURSE: Core -6 Practical**

**Laboratory-6 based on core-6 (BTUCLT2) CREDITS: 2**

**Course Objective**

The objective of the course is to give hands on exposure to isolate, handle, analyse and manipulate DNA material using molecular tools.

### Course Learning Outcomes

### Students who complete this course will be able to

### Isolate chromosomal and plasmid DNA from source organism.

### Learn how to use restriction enzymes to cut DNA molecule.

### Analyse the DNA material using biophysical methods.

### Learn transformation of bacterial cells for cloning.

**Course contents**

1. To Isolate the chromosomal DNA from plant cells/human cells /bacterial cells
2. To isolate the plasmid DNA from bacterial cells
3. Qualitative and quantitative analysis of DNA using agarose gel electrophoresis and spectrophotometer
4. To prepare the competent cells
5. To transform the of competent cells
6. To demonstrate the different types of PCR
7. To study the Restriction digestion of DNA using different restriction enzymes

**Suggested Reading**

1. Brown TA. Gene Cloning and DNA Analysis. Blackwell Publishing, Oxford, U.K.

2. Clark DP and Pazdernik NJ. Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

3. Glick, B.R., Pasternak, J.J. Molecular Biotechnology-Principles and Applications of recombinant DNA. ASM Press, Washington

4. Primrose SB and Twyman RM. Principles of Gene Manipulation and Genomics, Blackwell Publishing, Oxford, U.K.

5. Sambrook J, Fritsch EF and Maniatis T. Molecular Cloning-A Laboratory Manual. Cold Spring Harbor Laboratory Press.

**COURSE: Generic Elective-3 (GE- 3)**

**Food Biotechnology (BTUCTG1**) **CREDITS: 3**

**Course Objective**

The objective of the course is to make students knowledgeable about the application of Biotechnology in Food Science. This course will introduce them about role of Biotechnology in production, preservation, and packaging of food. The students will be taught about the biotechnological approaches for enhanced food production and nutritive values. The course will also cover the information about production of food items through alternative biotechnological approach including laboratory groan food items.

**Course Learning Outcomes**

After successful completion of course the students will able to:

* Describe the role of Biotechnology in Food production
* Define and understand the approaches for production of fermented food
* Explore the possible alternative foods
* Understand the concept of useful molecular methods for enhanced food production
* Design the strategies to increase nutritive value of food

**Course Contents**

**Unit I: Food Science and Biotechnology**

Overview of Biotechnology in food science, Food Processing Biotechnology, Food Processing Unit Operation, Quality parameters of Food. Regulations for food industries, Social ethics in food biotechnology.

**Unit II: Fermentative production of food**

Microbial fermentation; Starter cultures; Curdling products, Curd, Yoghurt, Cheese - principles of cheese making and their types, Fermented milk products, Fermented foods, Fermented vegetables: Sauer kraut, pickles, Olives, Kimchi, Fermented sausages, Alcoholic beverages: wine, brandy and beer etc.; Food additives: organic acid, amino acids, food flavoring agents and pigments.

**Unit III: Food Preservation and Packaging**

Microbial Biotechnology in Food Products, Role of microbes in food products, Microbial Food Spoilage; Use of microbes for production of food (Yeast; Bacteria and other microorganism-based process), Biotechnology in food preservation and packaging. Prevention of food deterioration.

**Unit IV: Alternative food items and Molecular Method for Food production**

Raw material for food and its modification, Bio conversion of food raw material, Conversion of food waste in value added products, Methods to increase nutrient values of food items. Alternative food products and their production: Microbes as food product, Mushrooms, Single cell protein, Aqua culture, Nutraceuticals, Laboratory grown food. Molecular methods to enhance food production; Techniques for development of new plant varieties, genetically modified organisms/transgenic organisms as food.

**Suggested Books**

* Food Microbiology (William C Frazier)  New York : McGraw-Hill
* Compendium of the Microbiological Spoilage of Foods and Beverages (William H. Sperber · Michael P. Doyle) Springer
* Introduction to Food Biotechnology (Perry Johnson-Green) CRC Press

# Food Biotechnology (SC Bhatia) CRC Press

# Food Biotechnology: Principles and Practices (VK Joshi) I.K. International Publishing House Pvt. Limited,

* Progress in Food Biotechnology (Ali Osman) Bentham Science Publishers

## Food Biotechnology (Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin) CRC Press

**COURSE: Generic Elective-3 (GE- 3) Practical**

**Laboratory (Based on GE-3) (BTUCLG1) CREDITS: 2**

**Course Objective**

The objective of the course is to make students knowledgeable about the various methods in Food Biotechnology. This course will allow them to perform the analysis of food for their qualitative and quantitative parameters. This course intent to provide learning experience in laboratory about nutritive value of food, its contamination content, process of food production, preservation, etc.

**Course Learning Outcomes**

After successful completion of course the students will able to:

* Evaluate the nutritive value of food.
* Detect the food spoilage
* Preserve the food items
* Produce the food through biotechnological approaches

**Course Contents**

1. Detection of bacterial load in food items.
2. Determination of spoilage of milk through dye reduction test.
3. Determination of protein contents in food items by Bradford’s Method.
4. Curdling of milk.
5. Determination of accuracy of blanching process for vegetable.
6. Production of alcoholic beverages and their distillation
7. Preservation of vegetables through pickling method.

**COURSE: Ability Enhancement Course – 3 (AEC - 3)**

**Intellectual Property Right and Entrepreneurship (BTUCTA1) CREDITS: 2**

**Course Objective**

The objective of the course is to introduce the students about the basic knowledge on intellectual property rights and their implications in biological research and product development; students become familiar with India’s IPR Policy; about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting there wards.

**Course Learning Outcomes**

Learning outcomes on completion of this course the students will be able to;

* Understand different types of intellectual property rights.
* Understand the protection of products derived from biotechnology research
* Understand Indian patent Act and issues related to application andobtaining patents.
* Understandentrepreneurial skills
* Understandrole of entrepreneurship in developing economy

**Course contents**

**Unit I**

Introduction to Indian Patent Law, World Trade Organization and its related intellectual property provisions, Intellectual/Industrial property and its legal protection in research, design, development in Biotechnology

**Unit II**

Essential requirements for patenting, types of patent, things that are patentable and non-patentable, Drug patents in India, various types of patent application in India, patenting of living organism, traditional knowledge, commercial exploitation and protection.

**Unit III**

Concept of entrepreneur, nature of entrepreneur, entrepreneurial characteristics, functions of an entrepreneur, role of entrepreneurship in developing economy.

**Unit IV**

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

**Suggested Reading**

1. Ganguli,P.(2001).IntellectualPropertyRights:UnleashingtheKnowledgeEconomy.New Delhi: Tata McGraw-Hill Pub.
2. NationalIPRPolicy,DepartmentofIndustrialPolicy&Promotion,Ministryof Commerce,GoI
3. CompleteReferencetoIntellectualPropertyRightsLaws.(2007). Snow White PublicationOct.
4. Kuhse,H.(2010).Bioethics:anAnthology.Malden,MA:Blackwell.
5. OfficeoftheControllerGeneralofPatents,Design&Trademarks;Departmentof Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India.<http://www.ipindia.nic.in/>
6. KarenF.GreifandJonF.Merz,CurrentControversiesintheBiologicalSciences-Case Studies of Policy Challenges from New Technologies, MIT Press
7. World Trade Organisation.[http://www.wto.org](http://www.wto.org/)
8. World Intellectual Property Organisation.[http://www.wipo.int](http://www.wipo.int/)

**Semester-IV**

**COURSE: Core -8 Theory**

**Bio-analytical Tools (BTUDTT1) CREDITS: 3**

**Course Objective**

The objective of the course is to develop the skills to understand the theory and practice of bioanalytical techniques. This course contains various bioanalytical techniques such as microscopy, spectroscopy, centrifugation, chromatography and electrophoresis along with their principle, instrumentation and applications. In addition to understanding the basic concepts and applications of bioanalytical techniques, this course provides scientific understanding of bioanalytical techniques and detail interpretation of results. This will lead to development of practical skills to undertake future analytical/research activities in Biotechnology.

**Course Learning Outcomes**

* Understanding the principle of microscopy and spectrophotometry and their applications in biological studies.
* Understanding the principle of centrifugation and cell fractionation and their applications in isolation of biomolecules and cell organelles.
* Understanding the principle of chromatography and their applications in separation of biomolecules.
* Understanding the principle of electrophoresis and blotting techniques and their applications in biological investigations/experiments.

**Course contents**

**Unit I**

History and Background of microscope, various types of microscope, principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), absorption and emission spectroscopy

**Unit II**

Centrifugation: principle and mechanism, types of rotors, types and techniques of centrifugation (differential and density gradient). Micro-techniques, Types cell fractionation techniques, isolation of sub-cellular organelles and particles

**Unit III**

Principle of chromatography, Paper chromatography, thin layer, chromatography, column chromatography: silica and gel filtration, affinity and ion exchange, chromatography, gas chromatography, HPLC.

**Unit IV**

Introduction to electrophoresis: Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immune-electrophoresis, isoelectric focusing, Southern, Northern, Western blotting and South-Western blotting

**Suggested Reading**

1. Keith Wilson and John Walker: Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, Cambridge, UK.
2. Karp, G. Cell and Molecular Biology: Concepts and Experiments. John Wiley& Sons. Inc.
3. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology. Lippincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell. Pearson Benjamin Cummings Publishing, San Francisco.

**COURSE: Core -8 Practical**

**Laboratory-8 based on core-8 (BTUDLT1) CREDITS: 2**

**Course Objective**

The objective of this course is to provide practical exposure of various bioanalytical techniques which are commonly used in a laboratory and applied in biological studies.

**Course Learning Outcomes**

* Students will obtain hands-on training in spectrophotometry and gain expertise in qualitative and quantitative analysis of biomolecules.
* Students will obtain hands-on training in chromatography to separate biomolecules.
* Student will acquire skills to separate proteins with the help of electrophoresis.

**Course contents**

1. To study relation between absorbance and % transmission using spectrophotometer
2. To separate different types of amino acids by paper chromatography (ascending method).
3. To separate the proteins by SDS-polyacrylamide gel electrophoresis.
4. To identify the lipids in a given sample by TLC.
5. To verify the validity of Beer’s law and determine the molar extinction coefficient of NADH.
6. To separate the plant pigments by adsorption column chromatography

**Suggested Reading**

1. Keith Wilson and John Walker: Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, Cambridge, UK.
2. Karp, G. Cell and Molecular Biology: Concepts and Experiments. John Wiley& Sons. Inc.
3. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology. Lippincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell. Pearson Benjamin Cummings Publishing, San Francisco.

**COURSE: Core -9 Theory**

**Immunology (BTUDTT2) CREDITS: 4**

**Course Objective**

This course aims at introducing the biology immune system and cellular and molecular events involved. This will help the students understand the host response in diseases; associated cellular and molecular events; anomalies associated with immune system and strategies to overcome them.

Objective of Immunology course are

1. To impart the knowledge of Components of immune system and their functioning
2. To make students understand about various molecular and cellular events and phenomenon like innate and adaptive immunity; cellular and humoral immunity; Primary and Secondary immunomodulation.
3. To provide concept of cellular differentiation and Activation of lymphoid and myeloid cells.
4. To make students familiar with immunological techniques
5. To provide understanding about how immune system protect us and what defects can be found in immune system (Autoimmunity, immunodeficiency, hypersensitivity).

**Course Learning Outcomes**

* On the successful completion of the course, students will be able to:
* Describe functioning of immune system through involved cells and molecules
* Differentiate between primary and secondary immune response; Innate and Adaptive Immunity; Cellular and Humoral Immunity.
* Describe the reactions of Ag-Ab, and explore its uses in Research and Application
* Describe the phenomena associated with immune response including various undesirable response found like hypersensitivity reactions, Autoimmune response; Immunodeficiencies.
* Describe the application of various techniques involved in Immunology.

**Course contents**

**Unit I**

Immune Response - An overview, Cells and organs of immune system, molecular structure of immunoglobulins, antigens, antigenicity and immunogenicity, humoral & cellular immune responses, T-lymphocytes (cytotoxic T-cell, helper T-cell, suppressor T-cells), B-lymphocyte and immune response, T-cell receptors B-cell receptors, genome rearrangements during differentiation of B cells.

**Unit II**

Regulation of immunoglobulin gene expression–clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, Antibody affinity maturation class switching, assembly of T-cell avidity receptor genes by somatic recombination.

**Unit III**

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Complement activation, autoimmune diseases, hypersensitivity, immunodeficiency-AIDS.

**Unit IV**

Immunity to infection: immunity to different organisms, pathogen defense strategies. Vaccines & Vaccination: adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization, Introduction to immunodiagnostics – RIA, ELISA.

**Suggested Reading**

1. Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology. Saunders Publication, Philadelphia.

2. Delves P, Martin S, Burton D, Roitt IM. Roitt’s Essential Immunology. Wiley-Blackwell Scientific Publication, Oxford.

3. Goldsby RA, Kindt TJ, Osborne BA. Kuby’s Immunology. W.H. Freeman and Company, New York.

4. Murphy K, Travers P, Walport M. Janeway’s Immunobiology. Garland Science Publishers, New York.

5. Peakman M, and Vergani D. Basic and Clinical Immunology. Churchill Livingstone Publishers, Edinberg.

6. Richard C and Geiffrey S Immunology. Wiley Blackwell Publication.

**COURSE: Core -9 Practical**

**Laboratory-based on core-9 (BTUDLT2) CREDITS: 2**

**Course Objective**

This course aims at introducing the various methods to study the components of immune system, evaluating the immune response; and immunological assays. In this course students will get familiar with the methods, and procedures of various assays related to immunology. This will help the students study and understand the components immune system, learn about methods to evaluate immune reactions and apply the immunological assays.

**Course Learning Outcomes**

On the successful completion of the course, students will be able to:

1. Identify various cells of immune system
2. Qualitatively Differentiate between antigens.
3. Perform assays based on antigen antibody interactions.
4. Detect the presence of specific antigen/antibody.
5. Apply the immunological assay for studying immune reactions.

**Course contents**

1. Total RBC count of blood sample using haemocytometer
2. To analyse the haemagglutination assay
3. To analyse the haemagglutination inhibition assay
4. To separation the serum and plasma from blood sample
5. To study the double immunodiffusion test using specific antibody and antigen.
6. To study the different types of ELISA

**Suggested Reading**

Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology. Saunders Publication, Philadelphia.

2. Delves P, Martin S, Burton D, Roitt IM. Roitt’s Essential Immunology. Wiley-Blackwell Scientific Publication, Oxford.

3. Goldsby RA, Kindt TJ, Osborne BA. Kuby’s Immunology. W.H. Freeman and Company, New York.

4. Murphy K, Travers P, Walport M. Janeway’s Immunobiology. Garland Science Publishers, New York.

5. Peakman M, and Vergani D. Basic and Clinical Immunology. Churchill Livingstone Publishers, Edinberg.

6. Richard C and Geiffrey S Immunology. Wiley Blackwell Publication.

**COURSE: Generic Elective-4 (GE- 4)**

#### Scientific Writing (BTUDTG1) CREDITS: 3

#### Learning Objective:

#### On completion of this course, the students will be able to understand about:

#### The features of communication

#### The various writing skills

#### The scientific and technical writings

#### Course Outcome

The Course aims at capacity building in:

* + - * Acquiring knowledge about different aspects of scientific, technical writing and communication
      * Hands on usage of related tools and techniques of scientific writing

#### Effective manuscript, project and review writing

**Course contents**

**Unit I: Communication and Writing Skills**

Language and communication, Speech and writing: differences and distinct features, Selection of topic, developing the hypothesis, introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, Overview of science writing, how is scientific writing different from general writing, know your audience, writing for general public, science reporting, Science news, explanatory writing, lengthy magazine article, popular articles and popular lectures. Reading material: Popular science magazine articles.

**Unit II: Technical Writing**

Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided. Authors, acknowledgements, reproducibility, plagiarism, Numbers, units, abbreviations and nomenclature used in scientific writing, Writing references, Power-point presentation. Poster presentation, IMRAD format.

**Unit III : Publishing work**

Publishing work: selection of journal, impact factors, h index, following author guidelines, on line submission, proof reading of a manuscript, understanding the symbols, reviewing of a manuscript, making corrections and answering reviewers query, galley proof reading, Writing research grant proposal, Book review, write up mini profiles of prominent scientists, letters to editor, opinion writing, interview of a scientist, career in scientific writing

**Unit IV: Ethics and Good Practical’s and Art of Scientific Writing**

Writing for scientific community, types of paper (short communication, original research article, review), the various components for each type and the content of each components (title, author affiliation, abstract, key words, introduction, material and methods, results and discussion, conclusion, references and bibliography, citation. Scientific writing and ethics, Introduction to copyright-academic misconduct. Ethics in writing, plagiarism, plagiarism checker on line.

**References**

1. Jane Gregory and Steve Miller, Science in Public: Communication, Culture, and Credibility, Plenum, New York, 1998.

2. James G, Paradis and Muriel L. Zimmerman, The MIT Guide to Science and Engineering Communication. MIT Press, UK, 2002.

3. J.V. Vilanilam, Science Communication and Development in India, Sage, New Delhi, 1993.

4. Michael Alley (1998) The Craft of Scientific Writing Paperback

5. Janice R. Matthews Robert W. Matthews (2014) Successful Scientific Writing 4th edition Cambridge University Press.

6. Stephen B Heard (2016) The Scientist's Guide to Writing: How to Write More Easily and Effectively throughout Your Scientific Career Princeton University Press

**COURSE: Generic Elective-4 (GE- 4) Practical**

**Laboratory (Based on GE-4) (BTUDLG1) CREDITS: 2**

#### Learning Objective:

#### On completion of this course, the students will be able to understand about:

#### The features of communication

#### The various writing skills

#### The scientific and technical writings

#### Course Outcome

The Course aims at capacity building in:

* + - * Acquiring knowledge about different aspects of scientific, technical writing and communication
      * Hands on usage of related tools and techniques of scientific writing

#### Effective manuscript, project and review writing

**Course contents**

1. Searching relevant scientific documents using appropriate keywords
2. Observing and reading various scientific documents (original research article, review article, graphical review etc.)
3. Detection of text similarity and plagiarism
4. Abstract Writing
5. Poster and graphical abstract preparation
6. Reference/bibliography styling

**COURSE: Ability Enhancement Course – 4 (AEC - 4)**

**Molecular techniques in disease diagnosis** **(BTUDTA1) CREDITS: 2**

**Course Objective**

The skill enhancement course prepares the student for a career in academia or industry or become a bioentrpreneur. The objective of the course is to introduce the basic knowledge of molecular techniques used in various disease diagnosis. Student will better understand the basic principle of different molecular techniques required for interpretation of disease.

**Course Learning Outcomes**

On the successful completion of the course, students will be able to:

* Know the collection, storage, transportation of sample or chemicals as well as follow the biosafety regulation and proper disposal of laboratory waste.
* Gain knowledge about various infectious, non-infectious and lifestyle diseases, tumors and their diagnosis.
* Know the composition of blood and different types of staining used to visualize the blood cells for disease diagnosis includes DLC, TLC, cytochemical staining etc.
* Understand the principle and application of advanced molecular techniques like PCR, RFLP, Immunoassays, Flouresence activated cell sorter, Magnetic cell sorter, FITR used in different types of disease diagnosis.
* Acquire knowledge about common imaging technologies and their utility in the clinic to diagnose a specific disease.

**Course contents**

**Unit I**

Transportation of different clinical materials to distant Laboratories, Proper storage of samples, Chemicals, antibodies and enzymes, common anticoagulants used-composition, amount, mechanism of action and methods of preparation of different types of vials, Biosafety measures and disposal of laboratory waste. Basics of quality control methods and Laboratory accreditation

**Unit II**

Composition of blood and its function, drawing of peripheral blood smear, staining & stain preparation, Methods of estimation of Haemoglobin, Methods of total counts of WBC, RBC, Platelets & fluids used, Blood Group (ABO & Rh), Cytochemical stain for diagnosis/differential diagnosis of leukemia/other diseases

**Unit III**

Susceptibility tests: Diffusion test procedures, Tests for bactericidal activity, Immunodiagnostic tests,Immuno florescence, Enzyme Immunoassays: Enzyme linked immunosorbent assay, Radioimmunoassay, Immunophenotyping, Flouresence activated cell sorter, Magnetic cell sorter, FTR, Spectrophotometry

**Unit IV**

Molecular techniques to detect genetic disorders: Polymerase chain reaction, Restriction fragment length polymorphism, Nuclear hybridization methods, Single nucleotide polymorphism and DNA finger printing

**Suggested Reading**

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker

2. J.F. Van Impe, Kluwer Advanced Instrumentation, Data Interpretation, and Control of

Biotechnological Processes,

3. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. University Press Publication.

4. Brooks GF, Carroll KC, Butel JS and Morse SA Jawetz, Melnick and Adelberg’s Medical

Microbiology. McGraw Hill Publication.

5. Goering R, Dockrell H, Zuckerman M and Wakelin D. Mims’ Medical Microbiology.

6. Joklik WK, Willett HP and Amos DB. Zinsser Microbiology Appleton Centuary-Crofts

publication.

7. Willey JM, Sherwood LM, and Woolverton CJ Prescott, Harley and Klein’s Microbiology.

McGraw Hill Higher Education

8. Michael Hoppert, Microscopic Techniques in Biotechnology

**COURSE: Summer Internship**

The students of BSc. Biotechnology have to undergo summer internship at the end of fourth semester.

**Course Objective**

* To provide extensive exposure of hands-on experience to the student in industry/University/Research Institute/Organization and acquire the experience work culture/environment and opportunities available therein.

**Guidelines for Summer Internship**

* + - * The student may opt for any one activity during summer vacation of fourth/fifth semester in an authorized Industry/University / Institute/Corporate Entity / NGO / Government Undertaking etc. as per his/her intended area of specialization/interest or in any functional/allied area of Biotechnology.
      * The duration of summer internship must be at least of 15 days.
      * The student must take written approval from the Head of the Department before joining the internship programme.
      * A mentor/ co-guide from the parent department should be appointed for all students. The students are expected to discuss the topic/area of their interest with their respective Mentor/guides and co guides.
      * The course (activity) may be a research topic – based on primary / secondary data or may be an operational assignment involving working by the student on a given task/assignment/project/ etc. in an organization / industry that may or may not involve wet lab experimental work depending on the selected assignment.
      * Students are expected to maintain a Progress Diary (duly signed by the guide/supervisor) that should contain the work carried out and the progress achieved regularly.
      * All the students have to prepare and submit a written Report, as per the time line given by the University/College, at the end of the internship.
      * Each participant will make at least two hard bound copies of internship report in the recommended format to be submitted to the parent and the host organization

**The report of Internship should contain:**

i. Certificate of completion of Internship by the Company/Industry/Institute etc. duly signed by competent authority

ii. Certificate by Head of the Department and faculty guide

iii. Formal feedback from the company guide if any.

iv. Summary of the internship program.

v. Outline of the problem/task undertaken.

vi. Research methodology & data analysis and report (in case of research topics only)

vii. Relevant review of the previous work /data on the taken topic.

viii. References in appropriate referencing styles.

ix. Outcome

**Assessment**: Performance of student will be assessed based on their summer internship report.

**Semester-V**

**COURSE: Core -11 Theory**

**Bioprocess Technology (BTUETT1) CREDITS: 3**

**Course Objective**

The course objective is to impart students the understanding of bioprocess development, designing of a process and application. The course deals with bioprocess technology and various components of fermentation and product formation. The role and design of fermenters with their components and applications is also discussed.

**Course learning outcomes**

The expected learning outcome of course will be:

* Students will get an understanding of basic principle components of fermentation technology, Types of microbial culture and its growth kinetics
* Students will acquire nn understanding of design and types of bioprocess vessels, principles of upstream processing. oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system
* Students will get knowledge of downstream processing, product recovery and purification

**Course Contents**

**Unit I**

Introduction to bioprocess technology, Range of bioprocess technology and its chronological Development, Basic principle components of fermentation technology, Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

**Unit II**

Design and types of bioprocess vessels: Significance of Impeller, Baffles, Sparger; Types of culture/production vessels: Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing: Media preparation, Inocula development and sterilization from straw dust.

**Unit III**

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

**Unit IV**

Introduction to downstream processing, product recovery and purification, effluent treatment, Microbial production of ethanol, amylase, lactic acid and single cell proteins

**Suggested Reading**

1. Casida LE. (Industrial Microbiology. Wiley Eastern Limited.

2. Crueger W and Crueger A. Biotechnology: A textbook of Industrial Microbiology. Panima Publishing Co. New Delhi.

3. Patel AH. Industrial Microbiology. Macmillan India Limited.

4. Stanbury PF, Whitaker A and Hall SJ. Principles of Fermentation Technology. Elsevier Science Ltd.

**COURSE: Core -11 Practical**

**Laboratory-11 based on core-11 (BTUELT1) CREDITS: 2**

**Course Objective**

The course objective is to impart student’s the skills related to microbial growth and bioprocess development.

**Course learning outcomes**

* Students will acquire skill to study the bacterial growth curve
* Students will acquire skill to calculate thermal death point of microorganisms
* Students will acquire skill to design, develop and analyse the production of industrially important metabolites and enzymes

**Course content**

1. To study the bacterial growth curve.

2. To calculate the thermal death point of a microbial sample.

3. Production and analysis of ethanol.

4. Isolation of industrially important (amylase producing) microorganism from natural resource.

5. Production and analysis of amylase.

6. Production and analysis of lactic acid.

**Suggested Reading**

1. Casida LE. (Industrial Microbiology. Wiley Eastern Limited.

2. Crueger W and Crueger A. Biotechnology: A textbook of Industrial Microbiology. Panima Publishing Co. New Delhi.

3. Patel AH. Industrial Microbiology. Macmillan India Limited.

4. Stanbury PF, Whitaker A and Hall SJ. Principles of Fermentation Technology. Elsevier Science Ltd.

**COURSE: Core -12 Theory**

**Plant and Animal Biotechnology (BTUETT2) CREDITS: 3**

**Course Objective**

The objective of this course is to provide basic knowledge of animal and plant tissue culture. This course is designed to make students aware about laboratory organization and techniques of plant and animal tissue culture. This course will also teach application of transgenic animals and transgenic plants

**Course Learning Outcomes**

After successful completion of the course student will be able to understand

* Concept of totipotency, dedifferentiation and redifferentiation
* Scope and application of animal cell culture technology
* Scope and application of plant tissue culture technology
* Organization of animal and plant tissue culture laboratory
* Culture media and buffers used in animal and plant tissue culture laboratory
* Animal cell culture techniques: primary culture, subculture of cell lines
* Plant tissue culture techniques: Callus culture, organ culture, suspension culture
* Application of transgenic animals and plants

**Course Contents**

**UNIT I: Basic Concepts of Animal Cell Culture**

Animal Cell Culture: Laboratory Organization, Buffer and culture media for animal cell culture, primary culture, subculture, established cell lines. Cell viability and cytotoxicity assays. Stem cell culture.

**UNIT II: Manipulation of Animal Cells in Laboratory**

Cell transformation and cell cloning, tissue engineering, transgenic animals, methods of introducing foreign genes into mice (retroviral vector method, microinjection method, embryonic stem cell method)

**UNIT III: Basic Concepts of Plant Tissue Culture**

Plant tissue culture: Totipotency, dedifferentiation and redifferentiation of cells. Organization of plant tissue culture laboratory. Constituents of plant tissue culture medium

**UNIT IV: Plant Tissue Culture Techniques**

Types of plant tissue culture: Callus culture, organ culture (embryo, seed, anther, pollen, ovary, meristem, nucellus, shoot and root culture), suspension culture, culture of isolated single cells, protoplast culture, somatic embryogenesis, micropropagation. Transgenic plants

**SUGGESTED READING**

1. Chawla, H. S. (2000). *Introduction to Plant Biotechnology*. Enfield, NH: Science.
2. Razdan, M. K. (2003). *Introduction to Plant Tissue Culture*. Enfield, NH: Science.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). *Plant Biotechnology: an Introduction to Genetic Engineering*. Oxford: Oxford University Press.
4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry & Molecular Biology of Plants*. Chichester, West Sussex: John Wiley & Sons.
5. Umesha, S. (2013). *Plant Biotechnology.* The Energy And Resources.
6. Glick, B. R., & Pasternak, J. J. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, D.C.: ASM Press.
7. Brown, T. A. (2006). *Gene Cloning and DNA Analysis: an Introduction*. Oxford: Blackwell Pub.
8. Primrose, S. B., & Twyman, R. M. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
9. Slater, A., Scott, N. W., & Fowler, M. R. (2003). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford: Oxford University Press.
10. Gordon, I. (2005). *Reproductive Techniques in Farm Animals*. Oxford: CAB International.
11. Levine, M. M. (2004). *New Generation Vaccines.* New York: M. Dekker.
12. Pörtner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Totowa, NJ: Humana Press.
13. Butler, M and Dawson, M. (eds.).: Cell Culture Lab Fax, Eds., Bios Scientific Publications Ltd., Oxford. Clynes, M. (ed).: Animal Cell Culture Techniques. Springer.
14. Sambrook & Russel. Molecular Cloning: A laboratory manual.
15. Freshney, Culture of Animal cell: A mannual of Basic Techniques
16. Masters, J. R. W. (ed): Animal Cell Culture – Practical Approach, Oxford Univ. Press.
17. Basega, R. (ed): Cell Growth and Division: A Practical Approach. IRL Press.
18. Mather, J.P and Barnes, D. (eds). : Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Academic Press.

**COURSE: Core -12 Practical**

**Laboratory-12 based on core-12 (BTUELT2) CREDITS: 2**

**Course Objective**

The objective of this course is to provide practical exposure of basic experiments of animal cell culture and plant tissue culture.

**Course Learning Outcomes**

After successful completion of the course student will be able to understand/perform

* Preparation of buffers and media for animal cell culture
* Sterilization and filtration of cell culture medium
* Trypsinization of cell lines
* Passaging of cell lines available in department laboratory
* Counting the viable cells using haemocytometer
* Preparation of media for plant tissue culture
* Surface sterilization of explants
* Inoculation of explants in culture medium for in vitro growth

**Course Contents**

1. To prepare buffer and media for animal cell culture
2. Sterilization and filtration of cell culture medium
3. Trypsinization of cell lines
4. Passaging of cell lines
5. To count the viable cells using haemocytometer
6. To prepare media for plant tissue culture
7. Surface sterilization of explant
8. Inoculation of surface sterilized explant in culture medium

**SUGGESTED READING**

1. Butler, M and Dawson, M. (eds.).: Cell Culture Lab Fax, Eds., Bios Scientific Publications Ltd., Oxford. Clynes, M. (ed).: Animal Cell Culture Techniques. Springer.
2. Sambrook & Russel. Molecular Cloning: A laboratory manual.
3. Freshney, Culture of Animal cell: A mannual of Basic Techniques
4. Masters, J. R. W. (ed): Animal Cell Culture – Practical Approach, Oxford Univ. Press.
5. Basega, R. (ed): Cell Growth and Division: A Practical Approach. IRL Press.
6. Mather, J.P and Barnes, D. (eds). : Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Academic Press.
7. Chawla, H. S. (2000). *Introduction to Plant Biotechnology*. Enfield, NH: Science.
8. Razdan, M. K. (2003). *Introduction to Plant Tissue Culture*. Enfield, NH: Science.
9. Slater, A., Scott, N. W., & Fowler, M. R. (2008). *Plant Biotechnology: an Introduction to Genetic Engineering*. Oxford: Oxford University Press.

**COURSE: Discipline Specific Elective (DSE-1)**

**MOOC courses (BTUETD1) CREDITS: 2 – 5\***

**MOOC courses\* to be selected/opted from SWAYAM portal [from a basket of course approved by BOS from time to time]**

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**COURSE: Discipline Specific Elective (DSE-2)**

**Review writing/case studies (BTUEED2) CREDITS: 5**

The students of BSc. Biotechnology in fifth semester will be allotted a guide (among faculty member of the department) to supervise one of the following:

* Review Writing
* Case study Report

**Course Objective**

This course will provide extensive exposure of reviewing the available scientific literature/studying cases which is essential to frame projects/experimental design/meta-analysis.

**Guidelines for Review writing/case studies**

* The student will be allotted a guide to supervise review writing/case studies.
  + - * A mentor from the parent department should be appointed for all students. The students are expected to discuss the topic/area of their interest with their respective Mentor/guides and co guides.
      * Students may undertake review writing in the field of Biotechnology or allied subjects under the guidance of a faculty in the parent institute
      * A review article or literature review should be a survey of previously published research on a topic.
      * The objective of a literature review should be to provide a critical evaluation of the data available from existing studies and identify potential research areas to explore.
      * Students must submit two copies of the review (duly signed by the supervisor, co-guide and Head of the institution).
      * Students may undertake case studies in the field of Biotechnology or allied subjects under the guidance of a faculty in the parent institute/ other institutes (research or educational)/hospital /industry or any suitable and relevant organization.
      * Students must submit two copies of report (duly signed by the supervisor, co guide and Head of the institution) explaining the detailed methodology, analysis, relevance/significance of the case study undertaken.

**Assessment**: Performance of student will be assessed based on their report.

**COURSE: Ability Enhancement Course – 5 (AEC - 5)**

**Biotechnology in Societal Welfare (BTUETA1) CREDITS: 2**

**Course Objective**

The objective of this course isto understand the basic concepts of advanced and emerging issues in biotechnology pertaining to societal welfare. The students will also understand the utility of biotechnology in solving societal issues.

**Course Learning Outcomes**

* Upon successful completion of the course, the student will be able to understand the basic concepts of advanced and emerging issues in biotechnology
* Analyze, and evaluate social and ethical issues in the conduct of biological research and application of biological knowledge
* Analyze the scientific method by formulating hypotheses, proposing testable predictions and then testing to reach supportable conclusions about biological processes and systems, and articulate the relevance of modern biology to society.
* Apply responsibilities to promote societal health and safety, upholding the trust given to the profession by the society.

**Course Contents**

**Unit I**

History of Biotechnology, Basic concepts of genes, Genetic engineering, Tools for manipulation of genes: introduction to recombinant DNA technology, Vectors and expression systems.

**Unit II**

Intellectual property rights, Recombinant DNA Debates, Biotechnology and Business, Patenting Life, Genetically Modified organisms and Genetically Modified Foods: Risk and Regulation.

**Unit III**

Assisted reproductive technologies: From the Pill to IVF, Cloning, Stem Cells, Eugenics, The Human Genome Project, Genetic Testing, Bioethics and Medicine.

**Unit IV**

Personalized medicine, Bioprospecting and Biocolonialism, Vaccines, Gene therapy, Clinical trials, Synthetic Biology and Bioterrorism, Organic farming: Biofertilisers and Biopesticides.

**References:**

1. Biotechnology and Society: An introduction. Hallam Stevens. University of Chicago Press.

2016.

2. W. Godbey, An Introduction to Biotechnology, The Science, Technology and Medical

Applications, 1/e, Woodhead Publishing, 2014.

3. J.M. Walker and R. Rapley, Molecular Biology and Biotechnology, 5/e, Royal society of chemistry, 2009.

4. B.R.Glick, J.J.Pasternak, C.L.Patten. Molecular Biotechnology.ASM Press. 2009.

**Semester-VI**

**COURSE: Core -13 Theory**

**Statistics in Biological Research (BTUFTT1) CREDITS: 3**

**Course Objective**

The objective of this course is to provide detailed knowledge of biostatistics. Understanding the concept of statistics is necessary for researchers to test their hypothesis and to analyse their experimental data to make firm conclusions.

### Course Learning Outcomes

After successful completion of the course student will be able to understand

* Scope and applications of biostatistics
* Collection, processing and presentation of data
* Measures of central tendency
* Measures of dispersion
* Correlation analysis and regression analysis
* Testing of hypothesis

**Course Contents**

**Unit I: Scope and Applications of Biostatistics**

Scope and applications of Biostatistics, samples and population concept, collection, processing and presentation of data, frequency distribution

**Unit II: Measures of Central Tendency**

Measures of central tendency: Arithmetic, Harmonic and Geometric Mean, Mode and Median, their applications, merits and demerits

**Unit III: Measures of dispersion**

Measures of dispersion, Variance, Standard Deviation, Coefficient of Variance, their applications, merits and demerits, Correlation analysis and Regression analysis, Concept of Probability

**Unit IV: Test of Significance**

Comparison of two data sets: testing of hypothesis, Student’s t-test, Chi square test, F-test- introduction and application in biology, comparison of three and more data sets: ANOVA test.

**Suggested Reading**

1. Le CT Introductory biostatistics. John Wiley, USA

2. Glaser AN High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA

3. Edmondson A and Druce D Advanced Biology Statistics, Oxford University Press.

4. Danial W Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

5. Mishra BN and Mishra SN, Principles of Biostatistics.

6. Marcello pagano, Principle of Biostatistics.

**COURSE: Core -13 Practical**

**Laboratory-13 based on core-13 (BTUFLT1) CREDITS: 2**

**Course Objective**

The objective of this course is to provide hands on training of experiments of biostatistics

**Course Learning Outcomes**

After successful completion of the course student will be able

* To study the data based on graphical representation (Bar, multiple bars, histogram, pie chart etc.)
* To determine the mean, median, mode and standard deviation of given sample/data
* To determine the probability of given sample/data
* To perform the t-test/F-Test of given data
* To perform the Chi-square test of given data

**Course Contents**

1. To study the data based on graphical representation (Bar, multiple bars, histogram, pie chart etc.)
2. To determine the mean, median, mode and standard deviation of given sample/data
3. To determine the probability of given sample/data
4. To perform the t-test/F-Test of given data
5. To perform the Chi-square test of given data

**Suggested Reading**

1. Le CT Introductory biostatistics. John Wiley, USA

2. Glaser AN High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA

3. Edmondson A and Druce D Advanced Biology Statistics, Oxford University Press.

4. Danial W Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

5. Mishra BN and Mishra SN, Principles of Biostatistics.

6. Marcello pagano, Principle of Biostatistics.

**COURSE: Core -14 Theory**

**Bioinformatics (BTUFTT2) CREDITS: 3**

**Course Objective**

The objective of this course is to provide detailed knowledge of bioinformatics. Learning bioinformatics is also necessary as modern biological research is greatly accelerated by use of computers.

### Course Learning Outcomes

After successful completion of the course student will be able to understand

* Introduction, scope and application of bioinformatics
* Introduction of biological databases
* Introduction of data generating techniques in genomics and proteomics
* Nucleotide and amino acid sequence alignments
* Genome annotation
* Phylogenetic analysis tools

**Course Contents**

**Unit I: Introduction and applications of bioinformatics**

Introduction to bioinformatics, Applications of Bioinformatics, General Introduction of Biological Databases: Flat files, relational, object oriented databases and controlled vocabularies File Format (Genbank, FASTA). Introduction of Data Generating Techniques for Genomics: shotgun sequencing, clone contig, Nucleic acid databases

**Unit II: Proteomics**

Introduction of Data Generating Techniques in proteomics: Mass spectroscopy. Protein databases (PDB, Swiss Prot, TREMBL). File Format (PDB). Searching Databases: SRS, Entrez

**Unit III: Sequence alignment**

Pairwise sequence alignments, Local alignment and Global alignment, Mutation/Substitution Matrices. Introduction to BLAST and interpretation of result, Multiple Sequence Alignment

**Unit IV:** **Gene identification and phylogenetic analysis**

Genome Annotation: Gene identification, Detecting Open Reading Frames, Phylogenetic analysis tools

**Suggested Reading**

1. Ghosh Z. and Bibekanand M. Bioinformatics: Principles and Applications. Oxford University Press.

2. Pevsner J. Bioinformatics and Functional Genomics. Wiley-Blackwell.

3. Campbell A. M., Heyer L. J. (Discovering Genomics, Proteomics and Bioinformatics. Benjamin Cummings.

4. Des Higgins and Willie Taylor, Bioinformatics: Sequence, Structure and Databanks. Oxford University Press.

5. Rashidi H. H. and Buehler. Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London.

6. Gibas Cynthia and Jambeck P. Developing Bioinformatics Computer Skills: Shroff Publishersand Distributors Pvt. Ltd. (O’Reilly), Mumbai.

**COURSE: Core -14 Practical**

**Laboratory-14 based on core-14 (BTUFLT2) CREDITS: 2**

**Course Objective**

The objective of this course is to provide hands on training of experiments of bioinformatics

**Course Learning Outcomes**

After successful completion of the course student will be able

* To understand and use various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
* To understand and use PDB, Swissprot, TREMBL
* To retrieve the gene from Genbank in the output file format
* To retrieve the protein from PDB in the output file format
* To align nucleic acid sequence using BLASTN
* To align protein sequence using BLASTP
* To align multiple sequence using Clustal W

**Course Contents**

1. To understand and use various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
2. To understand and use PDB, Swissprot, TREMBL
3. To retrievethe gene from Genbank in the output File format
4. To retrievethe protein from PDB in the output File format
5. To align nucleic acid sequence using BLASTN
6. To align protein sequence using BLASTP
7. To align multiple sequence using Clustal W

**SUGGESTED READING**

1. Ghosh Z. and Bibekanand M. Bioinformatics: Principles and Applications. Oxford

University Press.

2. Pevsner J. Bioinformatics and Functional Genomics. Wiley-Blackwell.

3. Campbell A. M., Heyer L. J. (Discovering Genomics, Proteomics and Bioinformatics. Benjamin Cummings.

4. Des Higgins and Willie Taylor, Bioinformatics: Sequence, Structure and Databanks. Oxford University Press.

5. Rashidi H. H. and Buehler. Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London.

6. Gibas Cynthia and Jambeck P. Developing Bioinformatics Computer Skills: Shroff Publishersand Distributors Pvt. Ltd. (O’Reilly), Mumbai.

**COURSE: Discipline Specific Elective (DSE-3)**

**Microbial Technology (BTUFTD1) CREDITS: 3**

**Course Objective**

The objective of the course is to give knowledge about bioprospecting and applications microorganisms. The course will allow student to know how microbiological techniques are used for production of microbial metabolites, microbial biomass and bioprocessing through potential microorganisms. This will develop interest among students to identify novel organisms and process development and apply in a better way.

### Course Learning Outcomes

### Students who complete this course will be able to

### Learn about bioprospecting and industrial microorganism

### Learn how microbial products are produced

### Learn potentials microorganism as biological control agent and biomass production.

### Learn how microorganisms are utilized for various bioprocessing/ bioconversions processes.

**Course contents**

**Unit I**

Introduction to Microbial biotechnology, Definition, Bioprospecting of microbial diversity, Isolation and preservation of industrially important microorganisms

**Unit II**

Production of proteins and enzymes in bacteria, recombinant vaccines, polysaccharides from microbes

**Unit III**

Microbes as biocontrol agents: microbial insecticides: their mode of action (Metarhiziumanisopliae, Bacillus thuringiensis, Nuclear Polyhedrosis Virus), requirements of biopesticide registration, insect resistance transgenic plants

**Unit IV**

Microbial biomass production, lignocellulose biodegradation, application of ligninolyticmicrorganisms and enzymes in biodegradation

**Suggested Reading**

1. Clark DP and Pazdernik NJ. Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

2. Glick, B.R., Pasternak, J.J Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

3. Glazer Hiroshi Nikaido    W.H.Freeman and Company Microbial Biotechnology Alexandern.

4. Bernaral R Molecular Biotechnogy: Principles and Applications of Recombinant DNA.

5. Fungal Ecology and Biotechnogy, Rastogi Publicaions, Meerut.

**COURSE: Discipline Specific Elective (DSE-3) Theory**

**Biodiversity and Bioprospecting (BTUFTD2) CREDITS: 3**

**Course objective**

The objective is to apprise students on various aspects of biodiversity and importance of its conservation. Students will also learn interrelation between biodiversity and bioprospecting and means to harness bioresources for industrial and therapeutic products. The course provides knowledge on components and importance of Biodiversity. It also gives a glimpse of principle and techniques of bioprospecting from various biological resources.

**Course learning outcomes**

* Students will acquire a fairly good understanding of the biodiversity and its components
* Students will get knowledge of the modern tools in the study, assessment and conservation of Biodiversity
* Students will acquire skills and information on bioprospecting from microbial, plant and animal resources

**Course contents**

**Unit I**

Components of biodiversity, Biodiversity crisis and biodiversity loss, Importance of biodiversity in daily life, Biodiversity and climate change, Types of Ecosystems, India as mega biodiversity Nation, Hot spots and biodiversity in India, Biodiversity and Ecosystem functioning, Plant and Animal systematic, Species concept in biodiversity studies

**Unit II**

Modern Tools in the study of Biodiversity, endemism, endemic plants and animals, assessment of mapping of biodiversity; GIS/Remote sensing; Biotechnology and Conservation, IUCN, Germplasm banks, National Parks, Botanical Gardens, Wild life Sanctuaries, Bioresources, Health and biodiversity

**Unit III**

Introduction to bioprospecting, bioprospecting from plants, plant derived drugs, botanicals for biocontrol, bioprospecting from animal sources, scope and examples

**Unit IV**

Bio-prospecting from microbes, micro-organisms as a source of novel enzymes, antibiotics, antiviral agents, immunosuppressive agents and other therapeutic agents

**Suggested Reading**

1. Aber, J.D.and Melillo J.M., Terrestrial Ecosystems, W.B.Saunders

2. Ingrowille, M Diversity and Evolution of land plants chapman and Hall

3. Arora, R.K. and Nayar, E.R. Wild relatives of crop plants in India, NBPGR Science

4. Baker, H.G. Plants and civilization (A. Wadsworth, Belmount).

5. Bole, P.V. and Vaghani, Y. Field guide to common Indian trees, Oxford University Press, Mumbai.

6. Thakur, R.S., Puri, H.S. and Husain, A. Major medicinal plants of India, Central Institute of medicinal and aromatic plants, Lucknow.

7. Swaminathan, M.S. and Kocchar, S.L. (Es.) Plants and Society, MacMillan Publication Ltd.

**COURSE: Discipline Specific Elective (DSE-3) Theory**

**Genomics and Proteomics (BTUFTD3) CREDITS: 3**

**Course Objective**

The objective of this course is to provide detailed knowledge of genomics and proteomics.

**Course Learning Outcomes**

After successful completion of the course student will be able to understand

* Introduction and scope of genomics and proteomics
* DNA and protein sequencing methods
* Genome sequencing, human genome project
* Genomic databases and genome analysis
* Analysis of proteomes
* Mass spectrometry based methods for protein identification

**Course Contents**

**Unit I: Genome sequencing**

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam& Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clonecontig) methods, Human genome project

**Unit II: Genome Browser**

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases

**Unit III: Introduction to protein structure**

Introduction to protein structure: Chemical properties of proteins. Physical interactions that determine the property of proteins, Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Sedimentation analysis, gel filteration, SDS-PAGE, Native PAGE, Determination of covalent structures, Edman degradation

**Unit IV: Proteome analysis**

Introduction to Proteomics: Analysis of proteomes, 2D-PAGE, Sample preparation, solubilization, reduction, resolution. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data

**Suggested Reading**

1. Benjamin Lewin, Johns, Genes Bartlett Publisher

2. S.B. Primrose, Modern Biotechnology Blackwell Publishing.

3. B.R. Glick, J.J. Pasternak and C.L. Patten Molecular Biotechnology: Principles and Applications of Recombinant DNA ASM Press, Washington.

4. Sambrook and Russell Molecular Cloning: A Laboratory Manual.

5. S.B.Primrose, R.M.Twyman and R.W. Old Principles of Gene Manipulation Blackwell Science.

6. Snustad, D.P., Simmons, M.J Principles of Genetics. John Wiley and Sons Inc.

7. Klug, W.S., Cummings, M.R., Spencer, C.A. Concepts of Genetics. Benjamin Cummings.

8. Russell, P. J,Genetics- A Molecular Approach. Benjamin Cummings.

9. Pevsner, J. Bioinformatics and Functional Genomics. John Wiley & Sons.

**COURSE: Discipline Specific Elective (DSE-3) Theory**

**Molecular Diagnostics (BTUFTD4) CREDITS: 3**

**Course Objective**

The skill enhancement course prepares the student for a career in academia or industry or become a bioentrpreneur. The objective of the course is to introduce the basic knowledge of molecular techniques used in various disease diagnosis. Student will better understand the basic principle of different molecular techniques required for interpretation of disease.

**Course Learning Outcomes**

On the successful completion of the course, students will be able to:

* Know the collection, storage, transportation of sample or chemicals as well as follow the biosafety regulation and proper disposal of laboratory waste.
* Gain knowledge about various infectious, non-infectious and lifestyle diseases, tumors and their diagnosis.
* Know the composition of blood and different types of staining used to visualize the blood cells for disease diagnosis includes DLC, TLC, cytochemical staining etc.
* Understand the principle and application of advanced molecular techniques like PCR, RFLP, Immunoassays, Flouresence activated cell sorter, Magnetic cell sorter, FITR used in different types of disease diagnosis.
* Acquire knowledge about common imaging technologies and their utility in the clinic to diagnose a specific disease.

**Course contents**

**Unit I**

Transportation of different clinical materials to distant Laboratories, Proper storage of samples, Chemicals, antibodies and enzymes, common anticoagulants used-composition, amount, mechanism of action and methods of preparation of different types of vials, Biosafety measures and disposal of laboratory waste. Basics of quality control methods and Laboratory accreditation

**Unit II**

Composition of blood and its function, drawing of peripheral blood smear, staining & stain preparation, Methods of estimation of Haemoglobin, Methods of total counts of WBC, RBC, Platelets & fluids used, Blood Group (ABO & Rh), Cytochemical stain for diagnosis/differential diagnosis of leukemia/other diseases

**Unit III**

Susceptibility tests: Diffusion test procedures, Tests for bactericidal activity, Immunodiagnostic tests,Immuno florescence, Enzyme Immunoassays: Enzyme linked immunosorbent assay, Radioimmunoassay, Immunophenotyping, Flouresence activated cell sorter, Magnetic cell sorter, FTR, Spectrophotometry

**Unit IV**

Molecular techniques to detect genetic disorders: Polymerase chain reaction, Restriction fragment length polymorphism, Nuclear hybridization methods, Single nucleotide polymorphism and DNA finger printing

**Suggested Reading**

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker

2. J.F. Van Impe, Kluwer Advanced Instrumentation, Data Interpretation, and Control of

Biotechnological Processes,

3. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. University Press Publication.

4. Brooks GF, Carroll KC, Butel JS and Morse SA Jawetz, Melnick and Adelberg’s Medical

Microbiology. McGraw Hill Publication.

5. Goering R, Dockrell H, Zuckerman M and Wakelin D. Mims’ Medical Microbiology.

6. Joklik WK, Willett HP and Amos DB. Zinsser Microbiology Appleton Centuary-Crofts

publication.

7. Willey JM, Sherwood LM, and Woolverton CJ Prescott, Harley and Klein’s Microbiology.

McGraw Hill Higher Education

8. Michael Hoppert, Microscopic Techniques in Biotechnology

**COURSE: Discipline Specific Elective (DSE-3) Practical**

**Laboratory (based on DSE-4 BTUFTD1) (BTUFLD1) CREDITS: 2**

**Course objective**

The objective of the course is to give hands on exposure to students on microbial Technology from isolation to application of microorganism for production of metyabolites as well as their use as biocontrol agents.

### Course Learning Outcomes

### Students who complete this course will be able to

* Isolate microorganism from environment, culture them and maintain in laboratory
* Learn to produce proteins and polysaccharides from microorganisms.
* Identify and use microorganisms as biocontrol agent

**Course contents**

1. To isolate microbes for bio-prospecting from biological soil

2. To preserve microbes using glycerol

3. To produce protein in *Escherichia coli*

4. To isolate microbes with the ability to secrete microbial polysaccharide

5. To isolate microbes having the bio-control potential

**Suggested Reading**

1. Clark DP and Pazdernik NJ. Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

2. Glick, B.R., Pasternak, J.J Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

3. Glazer Hiroshi Nikaido    W.H.Freeman and Company Microbial Biotechnology Alexandern.

4. Bernaral R Molecular Biotechnogy: Principles and Applications of Recombinant DNA.

5. Fungal Ecology and Biotechnogy, Rastogi Publicaions, Meerut.

**COURSE: Discipline Specific Elective (DSE-3)** **Practical**

**Laboratory (based on DSE-4 BTUFTD2) (BTUFLD2) CREDITS: 2**

**Course objective**

The objective is to provide students skill to study biodiversity of flora and fauna and means to bioprospect for value added products.

**Course learning outcomes**

* Students will acquire skill to study faunal composition (insects and mites) of soil and water samples.
* Students will acquire skills study the microbial diversity from soil sample/ water sample.
* Students will acquire skills to assess and value added products and activity from diverse microbial, plant and animal resources

**Course contents**

1. To study the faunal composition (insects and mites) of soil samples (Berley’s funnel)

2. To study faunal composition of water samples (Lucky drop method)

3. To study the microbial diversity from soil sample/ water sample

3. Report on visit to National Park/Wild life sanctuary/Botanical garden

4. Study through specimens/photographs/slides of: Source of Immunosuppresive and other

therapeutic agents, Botanicals for biocontrol, Sacred flora (havan materials etc.)

5. Study of the characteristic features of any two flowers for each family

(a) Malvaceae/ Fabaceae/Cruciferae/Ranunculaceae (any one family)

(b) Compositae

**Suggested Reading**

1. Aber, J.D.and Melillo J.M., Terrestrial Ecosystems, W.B.Saunders

2. Ingrowille, M Diversity and Evolution of land plants chapman and Hall

3. Arora, R.K. and Nayar, E.R. Wild relatives of crop plants in India, NBPGR Science

4. Baker, H.G. Plants and civilization (A. Wadsworth, Belmount).

5. Bole, P.V. and Vaghani, Y. Field guide to common Indian trees, Oxford University Press, Mumbai.

6. Thakur, R.S., Puri, H.S. and Husain, A. Major medicinal plants of India, Central Institute of medicinal and aromatic plants, Lucknow.

7. Swaminathan, M.S. and Kocchar, S.L. (Es.) Plants and Society, MacMillan Publication Ltd.

**COURSE: Discipline Specific Elective (DSE-3)** **Practical**

**Laboratory (based on DSE-4 BTUFTD3) (BTUFLD3) CREDITS: 2**

**Course Objective**

The objective of this course is to provide practical exposure of genomics and proteomics

**Course Learning Outcomes**

After successful completion of the course student will be able to perform/study

* Use of SNP databases at NCBI and other sites
* Use of OMIM database
* Detection of Open Reading Frames using ORF finder
* Proteomics 2D PAGE database
* Analyse of the Protein localization by using different softwares

**Course Contents**

1. Use of SNP databases at NCBI and other sites

2. Use of OMIM database

3. Detection of Open Reading Frames using ORF Finder

4. Proteomics 2D PAGE database

5. To analyse the Protein localization by using different Softwares.

6. Hydropathy plots

**Suggested Reading**

1. Benjamin Lewin, Johns, Genes Bartlett Publisher

2. S.B. Primrose, Modern Biotechnology Blackwell Publishing.

3. B.R. Glick, J.J. Pasternak and C.L. Patten Molecular Biotechnology: Principles and Applications of Recombinant DNA ASM Press, Washington.

4. Sambrook and Russell Molecular Cloning: A Laboratory Manual.

5. S.B.Primrose, R.M.Twyman and R.W. Old Principles of Gene Manipulation Blackwell Science.

6. Snustad, D.P., Simmons, M.J Principles of Genetics. John Wiley and Sons Inc.

7. Klug, W.S., Cummings, M.R., Spencer, C.A. Concepts of Genetics. Benjamin Cummings.

8. Russell, P. J,Genetics- A Molecular Approach. Benjamin Cummings.

9. Pevsner, J. Bioinformatics and Functional Genomics. John Wiley & Sons.

**COURSE: Discipline Specific Elective (DSE-3)** **Practical**

**Laboratory (based on DSE-4 BTUFTD4) (BTUFLD4) CREDITS: 2**

**Course Objective**

The objective of this practical is to build a confidence on students as the student will get an opportunity for hands on experience to develop their experimental skills. The students can apply this knowledge in medical field to pursue research or open a laboratory for human welfare.

**Course Learning Outcomes**

On the successful completion of the course, students will be able to:

* Learn basic laboratory techniques and safety rules.
* Develop skills in various types of tests and staining procedure involved in hematology, biotechnology at molecular level and the basics of instrument handling.
* Learn the scientific approaches/techniques used in the clinical laboratories to investigate various diseases.
* Get opportunity for hands on experience to develop their experimental skills

**Course contents**

*(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)*

1. Perform/demonstrate RFLP and its analysis on biological sample

2. To identify the microorganisms for different diseases

3. A kit-based detection of a microbial infection (Widal test)

4. To study the electron micrographs of biological sample

5. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)

6. To study the genetic disorders using molecular diagnostic tools

**Suggested Reading**

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker

2. J.F. Van Impe, Kluwer Advanced Instrumentation, Data Interpretation, and Control of

Biotechnological Processes,

3. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. University Press Publication.

4. Brooks GF, Carroll KC, Butel JS and Morse SA Jawetz, Melnick and Adelberg’s Medical

Microbiology. McGraw Hill Publication.

5. Goering R, Dockrell H, Zuckerman M and Wakelin D. Mims’ Medical Microbiology.

6. Joklik WK, Willett HP and Amos DB. Zinsser Microbiology Appleton Centuary-Crofts

publication.

7. Willey JM, Sherwood LM, and Woolverton CJ Prescott, Harley and Klein’s Microbiology.

McGraw Hill Higher Education

8. Michael Hoppert, Microscopic Techniques in Biotechnology

**COURSE: Discipline Specific Elective (DSE-4)**

**Project Dissertation (BTUFPD1) CREDITS: 7**

**Course objective**

It Involves Laboratory/ experimental/ field work under the guidance of a supervisor, leading to presentation of a comprehensive report based on the experiential learning, through focused skill building activity. The objective of this course is to help students in organization of research ideas, material, and objectives for their dissertation and development of communication skills.

### Course Learning Outcomes

* To acquire special/advanced knowledge in any branch/field of Biotechnology of interest to the student.
* Students can apply his or her knowledge in enhancing their analytical and problem solving skills and develop an interest in the field of biotechnology to pursue higher education and research.
* It will also enable the students to apply the knowledge gained to tackle various challenges in human health care and agriculture.

**Details of Topic:**

* Topic should be selected in consultation with the supervisor and should involve application of knowledge in solving /analyzing/ exploring the real life problems in human health care and agriculture.
* The student should be exposed to literature survey, lab work, collection of data and its presentation to give him/her glimpse of research training.
* The student must present the dissertation in bound form along with a certificate of supervisor and head of the department that experimental work has been done in the department.
* Theoretical review work will not be considered as project /dissertation.

**Evaluation of the dissertation:**

* Attendance: 10 marks
* Dissertation /Project Report: 30 Marks
* Presentation of the project work: 30 Marks

(Presentation should be done with the help of ppt and in the presence of faculties and external examiner)

* Viva Voce: 30 Marks

(To be conducted by the supervisor and external examiner from other university)

**COURSE: Seminar**  **CREDITS: 2**