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.

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.

POs Under-Graduate Programme

Programme Outcomes (POS)

PO1	**Knowledge:** To meet the professional requirements Knowledge will be provided on basics and advance fields of the core and applied subjects.
PO2	**Critical Thinking:** Special skill for critical thinking on contextual knowledge of living beings/ organisms, non-living components and environmental basis of life, enabling the students for critical analysis of day-to-day problems.
PO3	**Skill & Application Development**: Understanding of application of biological materials in food, health, medicine & environment for sustainable development of the society, development of skill-based knowledge on theory and methodology for use in descriptive and inferential statistical tools and techniques.
PO4	**Ethics:** Internalisation of and sensitiveness to sound professional ethics for use to solve societal problems.
PO5	**Inter-disciplinary & Multi-disciplinary Approach:** Understanding of the vital connections within and among the flora, fauna and the physical environment so is to enable to integrate and synthesized
PO6	**Problem Solving & Employability:** Special skill through vocational trainings, field visits, entrepreneurial and career development approach in research and development issues in the society.

Program Specific Outcomes

PSO 1	**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.
PSO 2	**Skilled communicator:** Ability to convey complex technical information relating to Biotechnology in a clear and concise manner both in writing as well as orally.
PSO 3	**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.
PSO 4	**Team player/worker:** Capable of working effectively in diverse teams in both classroom, laboratory as well as in field-based situations improving knowledge and developing skill.
PSO 5	**Ethical awareness/reasoning:** Avoiding unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, and sensitive towards environmental and sustainability issues.
PSO 6	**Lifelong learners:** Capable of making conscious efforts to achieve self-paced and self-directed learning aimed at personal development.

B.Sc. (HONOURS) BIOTECHNOLOGY

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 Outcome	**Biochemistry**
CO1	The course will provide students a guide in the basic, fundamental and detailed concepts of Cell Biology.
CO2	The students will be able to critically analyze biological problems through statistical methods. Students will be able to efficiently communicate statistically analyzed biological data in the form of graphical and tabular representation
CO3	The students will gain the knowledge about the cell cycle and how cells are dividing and biological basis of cancer and about the carcinogenic agents that may participate in cancer development. The students will gain understanding of ethical issues that must be considered during cell biology studies. The students will be able to analyze the biological data of real world by keep updating themselves on new statistical tools (lifelong learning).

Program Matrix

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

1													
CO 2	**2**	**3**	**3**	**1**	**1**	**1**		**2**	**3**	**3**	**1**	**1**	**1**
CO 3	**1**	**1**	**1**	**2**	**2**	**2**		**1**	**1**	**1**	**2**	**2**	**1**

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 Outcome	**Biochemistry**
CO1	The course will provide hands on training of experiments of Cell Biology
CO2	The students will be able to understand the effect of temperature and organic solvents on semi permeable membrane.
CO3	The students will gain understanding of ethical issues that must be considered during cell biology studies. Students will be able to differentiate plasmolysis and de-plasmolysis. The students will be able

	to differentiate prokaryotic cell and eukaryotic cells (lifelong learning).

Program Matrix

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

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 Outcome	**Biochemistry**
CO1	The students should be well-versed with the structure and function of various biomolecules, their metabolic synthesis and catabolism.
CO2	The students should have qualitative analysis of different types of biomolecules.
CO3	The students should have knowledge of basic structure and classification of biomolecules and their metabolic reactions and properties of carbohydrates, proteins, lipids, nucleic acids and enzymes.

Program Matrix

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

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 Outcomes	Bioethics and Biosafety
CO1	Describe the importance of general biosafety measures, guidelines and good laboratory practices.
CO2	Explain ethical issues against the molecular technologies and consumption of genetically modified foods.
CO3	Explain case studies related to woman health ethics, clinical trials, medical negligence and disposal of radioactive waste.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	1	3	3	1		3	2	1	1	3	3
CO2	3	2	1	3	3	1		3	2	1	1	3	3
CO3	3	2	1	3	3	1		3	2	1	1	3	3

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 Outcomes	Bioethics and Biosafety
CO1	Describe the importance good laboratory practices.
CO2	Identify the different hazardous symbols for different chemicals/reagents used in laboratory.
CO3	Analyses case study related to woman health ethics, clinical trials, medical negligence and disposal of radioactive waste.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	1	1	3	1		3	2	1	1	3	3
CO2	3	2	1	1	3	1		3	2	1	1	3	3
CO3	3	2	1	1	3	1		3	2	1	1	3	3

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 Outcome	**Biotechnology and Human Welfare (BTUATA1)** **CREDITS:2**
CO1	To introduce the scope of biotechnology for human welfare.
CO2	Students will be able to understand industrial agricultural and environmental biotechnology related techniques.
CO3	Students will be able to understand forensic science and molecular diagnosis related techniques.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	3	3	2		3	2	2	3	2	3
CO2	2	2	1	3	2	2		3	2	2	3	3	3
CO3	3	2	3	3	1	2		3	1	2	3	2	2

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

Plant Tissue 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, New Delhi.

Course Outcome	**Plant Tissue Culture (BTUATL1)** **COURSE: Skill Enhancement Course- 1 (SEC-1)**
CO1	The students should be well-versed with the methods and techniques of plant tissue culture and its application.
CO2	The students should have the understanding of plant tissue culture and involved techniques, micropropagation and In-vitro Fertilization.
CO3	The students should have knowledge of basic concepts of plant tissue culture, importance of media, how to produced beneficial plants for agricultural and horticultural benefits.

Program Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**		**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**3**	**2**	**1**	**2**	**1**	**3**		**3**	**2**	**1**	**3**	**1**	**3**
CO2	**2**	**3**	**1**	**1**	**2**	**3**		**3**	**1**	**2**	**2**	**1**	**3**
CO3	**3**	**1**	**2**	**3**	**1**	**2**		**1**	**3**	**2**	**3**	**1**	**2**

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 Outcome	**General Microbiology**
CO1	The course will provide students a guide in the basic, fundamental and detailed concepts of microbiology.
CO2	The students will be able to critically analyze Microbial diversity and microbial taxonomy. Students will be able to efficiently communicate harmful and beneficial activities of microbes
CO3	The students will gain the knowledge about Genetic recombination in bacteria (Transformation, Transduction and Conjugation). The students will gain understanding of ethical issues that must be considered during microbiology studies. The students will be able to analyze microbial growth, reproduction and metabolism (lifelong learning).

Program Matrix

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

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 Outcome	**Laboratory-3 based on core-3 (BTUBLT1)**
CO1	The course will provide students practical exposure of microbiological techniques and experiments.
CO2	Students will be able to perform sterilization techniques followed in microbiology laboratory, isolation and cultivation of bacteria from different sources.
CO3	The students will be able to perform staining of isolated bacteria using different methods, determination of the bacterial cell size by micrometry, enumeration of cell count of microorganisms. (lifelong learning).

Program Matrix

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

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 Outcome	**Genetics**
CO1	The course will develop a clear understanding of various aspects of genetics and genomes.
CO2	Understand the basic principles of Mendelian genetics, Allelic and non-allelic interactions and analyze the inheritance pattern. Students will be able to efficiently communicate chromosomal sex-determination mechanisms and dosage compensation.
CO3	The students will gain the knowledge about eukaryotic genomic organization and differentiate between unique and repetitive DNA. The students will gain understanding of ethical issues that must be considered during genetic studies. The students will be able to analyze gene and allele frequency using Hardy-Weinberg law and analyze population genetics problems (lifelong learning).

Program Matrix

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

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 Outcome	**Laboratory-4 based on core-4 (BTUBLT2)**

CO1	The course will provide students practical exposure of genetics techniques and experiments.
CO2	Students will be able to solve the problems based on Mendelian genetics using checker board. Students will be able to identify Barr body in different type of samples.
CO3	Students will be able to differentiate various human traits inherited in a family. The students will gain understanding of ethical issues that must be considered during genetic studies. Construct and interpret a karyotype prepared from a spread of metaphase chromosomes (lifelong learning).

Program Matrix

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

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 Outcome	**COURSE: Generic Elective-2 (GE- 2)** **Biostatistics (BTUBTG1) CREDITS: 3**
CO1	The students will be able to gain basic and advanced understanding of biostatistics along with its scope and applications
CO2	The students will be able to critically analyze biological problems through statistical methods. Students will be able to efficiently communicate statistically analyzed biological data in the form of graphical and tabular representation
CO3	The students will gain understanding of ethical issues that must be considered during statistical analyses of biological data. Students will be able to work in team to analyze the data of biological, medical and agricultural field. The students will be able to analyze the biological data of real world by keep updating themselves on new statistical tools (lifelong learning).

Program Matrix

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

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 Outcome	**COURSE: Generic Elective-2 (GE- 2) Practical** **Laboratory (Based on GE-2) (BTUBLG1) CREDITS: 2**
CO1	The students will be able to gain basic and advanced understanding of gar, multiple bars, histogram, and pie charts.
CO2	The students will be able to critically analyze biological problems through statistical tests of significance. Students will be able to efficiently communicate the statistics and parameters of biological data through mean, median, mode and standard deviation
CO3	The students will gain understanding of ethical issues that must be considered during statistical tests of significance of biological data. Students will be able to work in team to collect and analyze data. The students will be able to analyze the biological data of real world by keep updating themselves on new statistical methods (lifelong learning).

Program Matrix

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

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 Outcome	**UG II Semester (AEC)** **Bio-management of Environment (BTUBTA1)**
CO1	The student should have well verse to study the different techniques such as bioremediation (using microorganisms) and phytoremediation (using plants) techniques.
CO2	The student should have well aware to analyse environmental pollutants such as pesticides, heavy metals, radioactive substances etc. present in the soil, water and aquifers.
CO3	The student should have knowledge about biomanagement of Soil. Aware of the biomanagement of heavy metal and petroleum contaminant. The student should have the knowledge of bioremediation (using microorganisms) and phytoremediation techniques.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	2	1	3	2		2	2	2	1	1	2
CO2	2	2	1	1	2	3		3	2	2	2	1	2
CO3	3	2	1	2	1	2		3	2	2	1	2	1

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.

Course Outcome	**Skill Enhancement Course-2 (SEC-2) UG II SEM** **Animal Cell Culture (BTUBTL1)**
CO1	The student should have well aware about techniques of animal cell and tissue culture. This course will deals with how to cultured cells can be maintained in animal cell culture laboratory.
Co2	The student should have acquired experimental skill of Cell culture techniques and competence in laboratory techniques. Student will develop proficiency in establishing and maintaining of cell lines.
CO3	The objective of this course is to provide basic knowledge of animal cell culture. To conduct the independent research in the animal cell culture and its further application

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	2	3	2	3		3	2	2	1	3	2
CO2	3	2	1	3	2	2		3	1	2	1	3	2
CO3	3	2	1	2	1	2		3	2	2	1	2	1

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 Outcome	**COURSE: Molecular Biology (BTUCTT1)**
CO1	The students will be able to gain 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.
CO2	The students will be able to critically analyze the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage. Students will be able to efficiently communicate the process of transcription, RNA processing and translation in prokaryotes and eukaryotes.
CO3	The students will gain understanding of ethical issues that must be considered during molecular biology experiments. The students will apply the 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 (lifelong learning).

Program Matrix

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

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 Outcome	**COURSE: Laboratory-5 based on core-5 (BTUCLT1)**
CO1	This course will provide practical exposure of basic molecular biology techniques to study the DNA and RNA.
CO2	Student will acquire skills to isolate the chromosomal DNA from bacterial cells/plant cells/animal cells.
CO3	Student will acquire skills to check the quality of isolated genomic DNA & plasmid DNA, RNA.

Program Matrix

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

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 Outcome	**COURSE: Recombinant DNA Technology**
CO1	The students will learn about various tools and techniques applied in recombinant DNA technology.
CO2	The course will give basics of how DNA molecules are manipulated in order to clone and express in a different host.
CO3	This course 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.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	1	1	1		3	2	3	1	1	1
CO2	3	3	3	1	1	1		3	2	3	1	1	1
CO3	3	3	3	1	1	1		3	2	3	1	1	1

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 Outcome	**COURSE: Laboratory-6 (based on core-6)**(Recombinant DNA Technology Lab)
CO1	The objective of the course is to give hands on exposure to isolate, handle, analyse and manipulate DNA material using molecular tools.
CO2	Students will learn to isolate chromosomal and plasmid DNA from source organism and analysis of DNA using biophysical methods.
CO3	Students will learn about the use of restriction enzymes to cut DNA molecule and transformation of bacterial cells for cloning.

Program Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**		**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**3**	**2**	**3**	**1**	**1**	**1**		**3**	**2**	**3**	**2**	**1**	**1**
CO2	**3**	**2**	**3**	**1**	**1**	**1**		**3**	**2**	**3**	**2**	**1**	**1**
CO3	**3**	**2**	**3**	**1**	**1**	**1**		**3**	**2**	**3**	**2**	**1**	**1**

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 Outcome	**Food Biotechnology (BTUCTG1)** **COURSE: Generic Elective-3 (GE- 3)**
CO1	Students should be keep understanding in the field of biotechnology in food science, preservation, and packaging of food, biotechnological approaches for enhanced food production and nutritive values as well as the information about production of food items through alternative biotechnological approach including laboratory grown food items.
CO2	The students should have qualitative analysis of production of fermented food, explore the possible alternative foods, and know the useful molecular methods for enhanced food production.
CO3	The students should have knowledge of basic function and applicability of processed foods, chemistry of fermentation; design the strategies to increase nutritive value of food.

Program Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**		**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**1**	**3**	**2**	**2**	**1**	**3**		**3**	**2**	**1**	**3**	**1**	**3**
CO2	**3**	**1**	**2**	**1**	**2**	**3**		**3**	**1**	**2**	**2**	**1**	**3**
CO3	**3**	**2**	**1**	**3**	**1**	**2**		**2**	**1**	**2**	**3**	**1**	**2**

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 Outcome	**COURSE: Generic Elective-3 (GE- 3) Practical Laboratory (Based on GE-3) (BTUCLG1)**
CO1	The course will make students knowledgeable about the various methods in Food Biotechnology.
CO2	The students will be able to analye foods for their qualitative and quantitative parameters.
CO3	This course intent to provide learning experience in laboratory about nutritive value of food, its contamination content, process of food production,

	preservation, etc.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	2	2	2	1	3		3	2	1	3	1	3
CO2	3	1	2	1	1	3		3	1	2	2	1	3
CO3	3	2	1	3	1	2		2	1	2	3	1	2

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 and obtaining patents.
- Understand entrepreneurial skills
- Understand role 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

8. World Intellectual Property Organisation.http://www.wipo.int

Course Outcome	**COURSE: Ability Enhancement Course – 3 (AEC - 3) Intellectual Property Right and Entrepreneurship (BTUCT)**
CO1	The students should be well-versed with Patent and types of intellectual property rights, Indian patent Acts and issues related to application and obtaining patents.
CO2	The students should understand the protection of products derived from biotechnology research.
CO3	The students should have knowledge of entrepreneurial skills and role of entrepreneurship in developing economy

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1		2	3		3		1	1	1		2	
CO2	2	3	1	3		1		2	3	2	2	3	3
CO3	1	1	3	1	2	3		1	3	3	3		3

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 Outcome	**COURSE: Bio-analytical Tools**
CO1	The objective of the course is to develop the skills to understand the theory and practice of bioanalytical techniques.
CO2	This course contains various bioanalytical techniques such as microscopy, spectroscopy, centrifugation, chromatography and electrophoresis along with their principle, instrumentation and applications.
CO3	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.

Program Matrix

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

CO1	**3**	**3**	**3**	**1**	**1**	**1**		**3**	**2**	**3**	**1**	**1**	**1**
CO2	**3**	**3**	**3**	**1**	**1**	**1**		**3**	**2**	**3**	**1**	**1**	**1**
CO3	**3**	**3**	**3**	**1**	**1**	**1**		**3**	**2**	**3**	**1**	**1**	**1**

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 Outcome	**COURSE: Laboratory-8 based on core-8** (Bio-analytical Tools Lab)
CO1	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.
CO2	Students will obtain hands-on training in spectrophotometry and gain expertise in qualitative and quantitative analysis of biomolecules.
CO3	Students will acquire hands-on training to separate biomolecules with the help of chromatography and electrophoresis

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**3**	**2**	**3**	**1**	**1**	**1**		**3**	**2**	**3**	**2**	**1**	**1**
CO2	**3**	**2**	**3**	**1**	**1**	**1**		**3**	**2**	**3**	**2**	**1**	**1**
CO3	**3**	**2**	**3**	**1**	**1**	**1**		**3**	**2**	**3**	**2**	**1**	**1**

COURSE: Core -9 Theory

Immunology (BTUDTT2) CREDITS: 4

Course Objective

This course aims at introducing the biology of 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 Outcome	**COURSE: Immunology**
CO1	The objective of the course is to impart the knowledge of components of immune system and their functioning
CO2	Students will understand about various molecular and cellular events and phenomenon like innate and adaptive immunity; cellular and humoral

	immunity; Primary and Secondary immunomodulation.
CO3	This course will provide scientific understanding about how immune system protects us and what defects can be found in immune system (autoimmunity, immunodeficiency, hypersensitivity).

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	1	1	1		3	2	3	1	1	1
CO2	3	3	3	1	1	1		3	2	3	1	1	1
CO3	3	3	3	1	1	1		3	2	3	1	1	1

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 Outcome	**COURSE: Laboratory-9 based on core-9** (Immunology Lab)
CO1	The objective of this course is to provide practical exposure of various immunological techniques.
CO2	Students will obtain hands-on training in counting blood cells using haemocytometer. They will be able to separate the serum and plasma from blood sample.
CO3	Students will be able to apply the immunological assay for studying immune reactions. Students will be able to detect the presence of specific antigen/antibody.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	1	1	1		3	2	3	2	1	1
CO2	3	2	3	1	1	1		3	2	3	2	1	1
CO3	3	2	3	1	1	1		3	2	3	2	1	1

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 Outcome	**Course: Scientific Writing (BTUDTG1)**
CO1	The students will be able to acquire knowledge about different aspects of scientific and technical writing and communication.
CO2	Students will develop analytical attitude for writing manuscript, project and review effectively. Students will be able to efficiently communicate scientific knowledge through review and research articles and book chapters.
CO3	Students will be well versed on usage of tools and techniques of scientific writing. Students will be able to work in individually and in team to publish research and review articles and book chapters. The students will be able to keep updating themselves on ethics and good practices and art of scientific writing (lifelong learning).

Program Matrix

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

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 Outcome	**Course: Laboratory (Based on GE-4) (BTUDLG1)**
CO1	The students will be able to acquire knowledge about different aspects of scientific and technical writing and communication.
CO2	Students will be able to do abstract writing, poster and graphical abstract preparation, reference/bibliography styling
CO3	Students will be able to search relevant scientific documents using appropriate keywords. They will be able to observe and read various scientific documents (original research article, review article, graphical review etc.). In order to maintain publication ethics they will be able to detect text similarity and plagiarism (lifelong learning).

Program Matrix

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

CO 2	**2**	**3**	**3**	**3**	**3**	**3**		**2**	**3**	**3**	**1**	**3**	**3**
CO 3	**1**	**1**	**1**	**3**	**3**	**3**		**1**	**1**	**1**	**2**	**3**	**3**

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 Outcomes	**Course: Ability Enhancement Course – 4 (AEC - 4): Molecular techniques in disease diagnosis (BTUDTA1)**
CO1	Describe molecular technologies and its importance in disease diagnosis and therapy.
CO2	Gain knowledge about various infectious, non-infectious and lifestyle diseases, tumors and their diagnosis.
CO3	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.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	1	1	3		3	1	2	1	1	3
CO2	3	2	3	1	2	3		3	1	2	1	1	3
CO3	3	2	3	1	2	3		3	1	2	1	1	3

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.

Course Outcome	**Summer Internship**
CO1	The course will provide students extensive exposure of hands-on experience of biological tools and techniques.
CO2	The students will be able to critically design research objectives. Students will be able to efficiently communicate techniques of biotechnology industries.
CO3	The students will gain understanding of ethical issues that must be considered during research and development activities in industries. They will be able to incorporate good laboratory practices in their experiments. Students will be able to work in team to perform experiments in industrial setup. The students will be able to analyze the industrial problem of real world by keep updating themselves on new tools and techniques (lifelong learning).

Program Matrix

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

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 an 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 Outcome	**Course: Bioprocess Technology (BTUETT1)**
CO1	The course will impart students the understanding of bioprocess development, designing of process and application.
CO2	The course deals with bioprocess technology and various components of fermentation and product formation with special emphasis on the role and design of fermenters with their components and applications.
CO3	Students will get an understanding of basic principle components of fermentation technology, types of microbial culture and its growth kinetics. Students will acquire an understanding of design and types of bioprocess vessels, principles of upstream processing, oxygen requirement in bioprocess; mass transfer coefficient. Students will get knowledge of downstream processing, product recovery and purification (lifelong learning).

Program Matrix

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

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 Outcome	**Course: Laboratory-11 based on core-11 (BTUELT1)**
CO1	The course will impart student's the skills related to microbial growth and bioprocess development.
CO2	Students will acquire skills to study the bacterial growth curve and calculate thermal death point of microorganisms.

CO3	Students will acquire skill to design, develop and analyse the production of industrially important metabolites and enzymes (lifelong learning).

Program Matrix

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

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 Outcome	**Plant and Animal Biotechnology (BTUETT2)**
CO1	The course will provide basic knowledge of animal and plant tissue culture.
CO2	Students will be able to understand primary culture, subculture of cell lines, callus culture, organ culture and suspension culture.
CO3	Students will be able to understand and communicate the concept of totipotency, dedifferentiation and redifferentiation. They will understand the organization of animal and plant tissue culture laboratory (lifelong learning).

Program Matrix

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

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 Outcome	**Laboratory-12 based on core-12 (BTUELT2)**
CO1	The course will provide students practical exposure of basic experiments of animal cell culture and plant tissue culture.
CO2	Students will be able to prepare buffers and media for cell and tissue culture. They will be able to perform sterilization and filtration of cell culture medium.
CO3	Students will be able to perform trypsinization and passaging of cell lines, counting the viable cells using haemocytometer. Moreover, they will also be able to perform surface sterilization of explants, inoculation of explants in culture medium for in vitro growth.

Program Matrix

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

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 Outcome	**Course: Discipline Specific Elective (DSE-2): Review writing/case studies (BTUEED2)**
CO1	This course will provide extensive exposure of reviewing the available scientific literature/studying cases which is essential to frame projects/experimental design/meta-analysis.
CO2	The students will be able to critically analyze biological problems. Students will be able to efficiently communicate and present scientific data.
CO3	The students will gain understanding of ethical issues that must be considered during review writing and case studies. Literature review will provide a critical evaluation of the data available from existing studies and identify potential research areas to explore. The students will be able to analyze the biological data of real world by keep updating themselves through searching scientific literature available in public domain (lifelong learning).

Program Matrix

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

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

Biotechnology in Societal Welfare (BTUETA1) CREDITS: 2

Course Objective

The objective of this course is to 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.

Course Outcome	**Course: Discipline Specific Elective (DSE-2): Review writing/case studies (BTUEED2)**
CO1	This course will provide understanding of the basic concepts of advanced and emerging issues in biotechnology pertaining to societal welfare.
CO2	The students will be able to critically 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.
CO3	The students will be able to analyze and evaluate social and ethical issues in the conduct of biological research and application of biological knowledge. The students will be able to apply responsibilities to promote societal health and safety, upholding the trust given to the profession by the society (lifelong learning).

Program Matrix

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

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.

Course Outcome	**Statistics in Biological Research (BTUFTT1)**
CO1	The students will be able to gain basic and advanced understanding of biostatistics along with its scope and applications
CO2	The students will be able to critically analyze biological problems through statistical tools. Students will be able to efficiently communicate statistically analyzed biological data in the form of graphical and tabular representation
CO3	The students will gain understanding of ethical issues that must be considered during statistical analyses of biological data. Students will be able to work in team to analyze the data of biological, medical and agricultural field. The students will be able to analyze the biological data of real world by keep updating themselves on new statistical tools (lifelong learning).

Program Matrix

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

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 Outcome	**Laboratory-13 based on core-13 (BTUFLT1) CREDITS: 2**
CO1	The students will be able to gain basic and advanced understanding of Bar, multiple bars, histogram, pie chart
CO2	The students will be able to critically analyze biological problems through statistical tests of significance. Students will be able to efficiently communicate the statistics and parameters of biological data through mean, median, mode and standard deviation
CO3	The students will gain understanding of ethical issues that must be considered during statistical tests of significance of biological data. Students will be able to work in team to collect and analyze data. The students will be able to analyze the biological data of real world by keep updating themselves on new statistical methods (lifelong learning).

Program Matrix

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

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 Outcome	**Bioinformatics (BTUFTT2)**
CO1	The students will be able to gain basic and advanced understanding of bioinformatics along with its scope and applications
CO2	The students will be able to critically analyze biological problems through bioinformatics tools. Students will be able to efficiently communicate biological data through bioinformatic analysis.
CO3	The students will gain understanding of ethical issues that must be considered during bioinformatic analyses of genomic, transcriptomic and proteomic data. Students will be able to work in team to analyze the data of biological, biomedical and agricultural field. Learning bioinformatics is also necessary as modern biological research is greatly accelerated by use of computers. (lifelong learning).

Program Matrix

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

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
5. To retrievethe protein from PDB in the output File format
6. To align nucleic acid sequence using BLASTN
7. To align protein sequence using BLASTP
8. 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 Outcome	**Laboratory-14 based on core-14 (BTUFLT2)**
CO1	The students will be able to gain hands on training of experiments of bioinformatics.
CO2	The students will be able to critically analyze nucleotide and amono acid sequence data through BLASTN, BLASTP and Clustal W algorithms.
CO3	The students will be able to retrieve and analyze the biological data of real world by keep updating themselves on bioinformatics databases such as EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR) etc (lifelong learning).

Program Matrix

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

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 Outcome	**Microbial Technology (BTUFTD1)**
CO1	The students will be able to gain basic and advanced knowledge about bioprospecting and applications of microorganisms.
CO2	The students will be able to critically analyze biological problems through statistical tools. The course will allow student to know how microbiological techniques are used for production of microbial metabolites, microbial biomass and bioprocessing through potential microorganisms.
CO3	This course will develop interest among students to identify novel organisms and process development and apply in a better way (lifelong learning).

Program Matrix

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

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 Outcome	**Biodiversity and Bioprospecting (BTUFTD2)**
CO1	This course will apprise students on various aspects of biodiversity and importance of its conservation.
CO2	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.
CO3	Students will also learn interrelation between biodiversity and bioprospecting and means to harness bioresources for industrial and therapeutic products (lifelong learning).

Program Matrix

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

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 Outcome	**Genomics and Proteomics (BTUFTD3)**
CO1	The course will provide detailed knowledge of genomics and proteomics.
CO2	The students will be able to critically analyze biological data of genome, transcriptome and proteome. Students will be able to efficiently communicate human genome, high throughput sequencing and system biology.
CO3	The students will gain understanding of ethical issues that must be considered during sequencing human genome. Students will be able to work in team to analyze the data of biomedical field. The students will be able to analyze the biological data of real world by keep updating themselves on new genomic, transcriptomic and proteomic tools (lifelong learning).

Program Matrix

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

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 Outcomes	Molecular Diagnostics
CO1	Describe molecular technologies and its importance in disease diagnosis and therapy.
CO2	List molecular methods used for identification of communicable and noncommunicable diseases.
CO3	Explain quality control in various platforms used in molecular disease diagnosis.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3		1	3		3	1	2	1	1	3
CO2	3	2	3		2	3		3	1	2	1	2	3
CO3	3	2	3		2	3		3	1	2	1	3	3

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)