VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)

Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

Approved in 13th Meeting of Executive Council held on 27th March 2023 subsequent to the 14th Meeting of Academic Council held on 20th March 2023

(For admission in 2022-23 and onwards)

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SYLLABUS

For

B.TECH

(Biotechnology)

2nd Year

Effective From – Session 2023-24

Semester-III												
S. No.	**Subject Codes**	**Subject Name**	**Periods**			**Sessional Exam**			**ESE**		**Subject Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1.	BTT002	Statistical Techniques in Biotechnology	3	1	0	30	20	50	100		150	4
2.	AHT007	Technical Communication/Universal Human Values	2	1	0	30	20	50	100		150	3
	AHT008		3	0	0							
3.	BTT003	Cell & Molecular Biology	3	1	0	30	20	50	100		150	4
4.	BTT004	Biochemistry	3	1	0	30	20	50	100		150	4
5.	BTT005	Microbiology	3	1	0	30	20	50	100		150	4
6.	BTP001	Cell & Molecular Biology Lab	0	0	2		25	25		25	50	1
7.	BTP002	Biochemistry Lab	0	0	2		25	25		25	50	1
8.	BTP003	Microbiology Lab	0	0	2		25	25		25	50	1
9.	BTP004	Internship-I/Mini Project-I*	0	0	2			50			50	1
10.	CST009	Cyber Security	2	0	0	15	10	25	50			
11.	GP03	General Proficiency						50				
		Total									**950**	**23**
		Minor Course (Optional)	3	1	0	30	20	50	100			**4**
*The Mini Project-I or Internship-I (3-4 weeks) conducted during summer break after II semester and will be assessed during III semester												
MOOCs course												

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week,
CT-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance,
PS-Practical Sessional Marks, **ESE**-End Semester Examination, **TE**- Theory Examination Marks,
PE- Practical External Examination Marks

Semester-IV												
S. No.	**Subject Codes**	**Subject Name**	**Periods**			**Sessional Exam**			**ESE**		**Subject Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1.	AHT008	Universal Human Values /Technical Communication	3	0	0	30	20	50	100		150	3
	AHT007		2	1	0							
2.	BTT006	Biophysics & Structural Biology	3	1	0	30	20	50	100		150	4
3.	BTT007	Bioprocess Engineering	3	1	0	30	20	50	100		150	4
4.	BTT008	Genetic Engineering and Recombinant DNA Technology	3	1	0	30	20	50	100		150	4
5.	BTT009	Immunology	3	1	0	30	20	50	100		150	4
6.	BTP005	Bioprocess Engineering Lab	0	0	2		25	25		25	50	1
7.	BTP006	Genetic Engineering and Recombinant DNA Technology Lab	0	0	2		25	25		25	50	1
8.	BTP007	Immunology Lab	0	0	2		25	25		25	50	1
9.	CST005	Python Programming	2	0	0	15	10	25	50			
10.	GB04	General Proficiency						50				
		Total									**950**	**23**
11.		**Minor Course (Optional)**	3	1	0	30	20	50	100			**4**
	*The Mini Project-II or Internship-II (3-4 weeks) conducted during summer break after IV semester and will be assessed during V semester											
	MOOC											

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week, **CT**-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance, **PS-**Practical Sessional Marks, **ESE**-End Semester Examination, **TE**- Theory Examination Marks, PE- Practical External Examination Marks

STATISTICAL TECHNIQUES IN BIOTECHNOLOGY (BTT-002)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To learn statistical concepts and terminology and basic analytic techniques.
2. To understand the basic concepts and principles of test of hypothesis and probability and will learn to use them with respect to biological data.
3. To be aware about the classification and graphical representation of various types of data and will learn to apply basic statistical concepts such as measures of central tendencies, measures of dispersion and sampling inareas of biotechnology.

COURSE OUTCOMES

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

1. Apply basic statistical concepts commonly used in Health and Medical Sciences.
2. Apply statistical methods to solve biological problems.
3. Interpret results of commonly used statistical analyses in written summaries.
4. Demonstrate statistical reasoning skills correctly and contextually.
5. Use basic and modern statistical software to analyse the biological and clinical data.

SYLLABUS

UNIT–I **(8 hours)**

Introduction to Biostatistics & Biometrical Techniques: Biostatistics, Characteristics of Statistics, Importance and Usefulness of statistics, Limitation of Statistics. Data: Types of Data, Population Presentation of Data: Frequency distribution, graphical presentation of data by histogram, frequency curve and cumulative frequency curves, Measure of Location and Dispersion: Mean, Medium, Mode and their simple properties (Without derivation) and calculation of median by graphs: range, mean deviation, Standard deviation, Coefficient of variation, Biometrical techniques, Some early Biometricians, Some Indian Biometrician, Applications in crop improvement, Probability, probability density function

UNIT–II **(8 hours)**

Correlation and Regression: Bivariate data – simple correlation and regression coefficients and their relation, Limits of correlation coefficient, Linear regression and equations of line of regression

Sampling Techniques in Biology: Concept of population and sample, Random sample, Methods of taking a simple random sample, Tests of Significance: Small sample tests (t-test for an assumed mean and equality of means of two populations when sample observations are independent, Paired and unpaired t-test for correlation and regression coefficients, T-test for comparison of variances of two populations, Chi-square test for independence of attributes, Goodness of fit and homogeneity of samples. Sampling methods of biological populations. Hypothesis testing, null hypothesis, alternate hypothesis, Statistical hypothesis

UNIT–III **(8 hours)**

Probability in biology: Comprehensive theory of probability in living systems.

Biological Experimental Designs: Introduction: Collecting Data and Experimental Design, Principles of experimental designs: Elements of Good Experimental Design, Randomization, Confounding, completely randomized, Randomized block and Latin square designs, Statistical design of experiments for clinical and laboratory data Type of Design, screening, optimization.

UNIT–IV **(8 hours)**

Analysis of variance (ANOVA): Types of ANOVA, and its use in the analysis of RBD, (Randomized BlocksDesign), Augmented block design (ABD), Analysis of data generated from augmented design.

Statistical genetics: Genetic progress and other related statistical methods in genetics.

UNIT–V **(8 hours)**

Mathematical Statistics for Biologists and Agricultural Statistics: Use of statistical methods in agricultureand allied fields, Importance of Agricultural Statistics.

STATISTICAL TECHNIQUES IN BIOTECHNOLOGY (BTT-002)

L:T:P::3:1:0 **Credits-4**

Computational and Statistical Genomics: Application of computationally intensive approaches to analyzelarge-scale genetic and genomic data.

TEXT /REFERENCE BOOKS:

1. Norman T.J. Bailey (1995) Statistical methods in biology (3rd Edition), Cambridge University Press.
2. S. C. Gupta and V. K. Kapoor (2003), Fundamentals of Mathematical Statistics, Sultan Chand and Sons,New Delhi.
3. P. Singh and S.S. Narayanan (2000), Biometrical Techniques in Plant Breeding, Kalyani Publisher, NewDelhi.
4. D. C. Montgomery, G. C. Runger (2018),Applied Statistics and Probability for Engineers, Wiley Publisher

Technical Communication (AHT-007)

L:T:P:: 2:1:0 **Credits-3**

COURSE OBJECTIVES:

Students should be able to:

1. To produce technical documents that use tools commonly employed by engineering and computer science professionals.
2. To communicate effectively in a professional context, using appropriate rhetorical approaches for technical documents, adhering to required templates, and complying with constraints on document format.
3. To clarify the nuances of phonetics, intonation and pronunciation skills.
4. To get familiarized with English vocabulary and language proficiency.

COURSE OUTCOMES:

1. Students will be enabled to **understand** the nature and objective of Technical Communication relevant for the work place as Engineers.
2. Students will **utilize** the technical writing for the purposes of Technical Communication and its exposure in various dimensions.
3. Students would imbibe inputs by presentation skills to **enhance** confidence in face of diverse audience.
4. Technical communication skills will **create** a vast know-how of the application of the learning to promote their technical competence.
5. It would enable them to **evaluate** their efficacy as fluent & efficient communicators by learning the voice-dynamics.

COURSE CONTENTS:

Unit -1 Fundamentals of Technical Communication:

Technical Communication: Introduction, Features; Distinction between General and Technical Communication; The flow of Communication: Downward; upward, Lateral or Horizontal; Barriers to Communication, Importance of communication

Unit - II Forms of Technical Communication:

Technical Report: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; 7 Cs of effective business writing: concreteness, completeness, clarity, conciseness, courtesy, correctness, consideration.

Unit - III Technical Presentation: Strategies & Techniques

Presentation: Forms; interpersonal Communication; Class Room presentation; style;method, Public Speaking: method; Techniques: Clarity of substance; emotion; Humour; Modes of Presentation; Overcoming Stage Fear: Confident speaking; Audience Analysis & retention of audience interest; Methods of Presentation: Interpersonal; Impersonal; Audience Participation: Quizzes & Interjections

Unit - IV Technical Communication Skills

Interview skills; Group Discussion: Objective & Method; Seminar/Conferences Presentation skills: Focus; Content; Style; Argumentation skills: Devices: Analysis; Cohesion & Emphasis; Critical thinking; Nuances, exposition, narration and description

Unit - V Kinesics & Voice Dynamics:

Kinesics: Definitions; importance; Features of Body Language; Voice Modulation: Quality, Pitch; Rhythm; intonation, pronunciation, articulation, vowel and consonants sounds

Reference Books

1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2007, New Delhi.
2. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.

3. Practical Communication: Process and Practice by L.U.B. Pandey; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, 2014, Delhi.
4. Modern Technical Writing by Sherman, Theodore A (et.al); Apprentice Hall; New Jersey; U.S.
5. A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.
6. Skills for Effective Business Communication by Michael Murphy, Harward University, U.S.
7. Business Communication for Managers by Payal Mehra, Pearson Publication, Delhi.

UNIVERSAL HUMAN VALUES (AHT-008)

L:T:P:: 3:0:0 **Credits-3**

Course objectives : The objective of the course is four fold:

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Course Outcomes :

1. Students are expected to become more aware of themselves, and their surroundings (family, society, nature)
2. They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. They would have better critical ability.
4. Theywould also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. It is hoped that they would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

COURSE TOPICS: *The course has 28 lectures and 14 practice sessions in 5 modules:*

Module 1: Introduction - Value Education

Universal human values; self exploration, natural acceptance an experimental validation; Human aspirations, right understanding, relationship and physical facility, current scenario; Understanding and living in harmony at various levels.

Module 2: Harmony in the Human Being

Understanding human being, needs of self(I) and body; body as an instrument of 'I'; characteristics and activities of 'I' and harmony in 'I'; harmony of I with the Body: Sanyam and Health, Physical needs an prosperity; Programs to ensure Sanyam and Health.

Module 3: Harmony in the Family and Society

Values in human-human relationship; nine universal values in relationships; justice, truth, respect, trust; Difference between intention and competence; Respect and differentiation, Harmony in society: resolution, prosperity, fearlessness and coexistence; Universal harmonious order in society.

Module 4: Harmony in the Nature and Existence

Harmony in the nature. Four orders of nature; existence as co-existence, harmony at all levels of existence.

Module 5: Harmony in the Professional Ethics

Natural acceptance of human values**,** Definitiveness of Ethical Human Conduct**;** Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case studies; transition from the present state to Universal Human Order: at individual level and societal level.

READINGS: Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karam chand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa

8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

CELL AND MOLECULAR BIOLOGY (BTT-003)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES:

1. To enrich knowledge about overview of basic cell and molecular biology.
2. The composition, structure and function of organelles and other cellular components are discussed whichlead to understanding of how cells contribute to the overall functioning of the organism.
3. To understand about nucleic acid structure and molecular processes that occurs in cell.
4. Enrich knowledge about the central dogma of life: information flow from DNA to Protein.

COURSE OUTCOMES:

On successful completion of this course students will be able to:

1. Summarize cellular and nuclear organizations.
2. Understand cell signalling, receptors and signal transduction.
3. Articulate the fundamental of models and enzymology of DNA replication.
4. Conclude the mechanism of transcription and Translation.
5. Acquire knowledge of regulation of gene expression in prokaryotes and eukaryotes

SYLLABUS

UNIT-I **(8 hours)**

Cell structure and function of the organelles: Prokaryotic and eukaryotic cells, nuclear structure, nucleolus, nuclear transport and chromatin packing, Cytoskeletal elements and architecture, actin and filament based motile systems, Cell cycle and cell growth control

UNIT-II **(8 hours)**

Cell membrane and permeability: Chemical components of biological membranes, organization and fluidity ofmembrane components, the membrane as a dynamic entity, cell and membrane transport.

UNIT-III **(8 hours)**

Organization of transport activity in cell; Signal Transduction, Cell signalling: Types of signalling, Cell surface receptor mediated signalling (RTK, pathway, JAK-STAT pathway), G proteins and G-protein coupled receptors, Secondary messengers and intra cellular communication, Target cell adaptation.

UNIT-IV **(8 hours)**

DNA replication: Enzymology of DNA replication, Difference in the replication process between prokaryotes and eukaryotes, initiation, elongation and termination of replication.

UNIT-V **(8 hours)**

Transcription, mRNA processing and Translation: Post translational modifications of transcript: capping, polyadenylation, splicing, mRNA stability, Regulation of gene expression in prokaryotes and eukaryotes; Operon model.

TEXT /REFERENCE BOOKS:

1. Alberts, Bruce (et.al) (2014). Molecular Biology of cell, 6thed. Garland Science Publishing, New York.
2. B. Lewin, (2002). Gene IX by Cell and Molecular Biology, 8th ed. Lippincot Williams and Wilkins Pvt.Ltd. (International Student Edition) Philadelphia.
3. Lodish, Harvey and Baltimore, (2000). Molecular Cell Biology 4th ed. W.H. freeman & Co. New York.

BIOCHEMISTRY (BTT-004)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES:

1. Study the structure and properties of water and carbohydrates.
2. Discuss the structure, properties and reactions of proteins and amino acids
3. Discuss the structure, properties of fats and lipids
4. To study the composition, structure and functions of nucleic acids
5. Learn the basic concept of metabolism.

COURSE OUTCOMES:

After the completion of the cours, students will

1. Appreciate the role of chemistry in biological science.
2. Able to Develop fundamental understanding about biomolecules and metabolism.
3. Able to develop understanding of advanced subjects such as metabolic engineering.
4. Develop skills to understand the theory and practice of experiments related tobiochemistry.

SYLLABUS

UNIT-1 **(8 Hours)**

Biochemistry: Introduction as a discipline, historical perspective, major landmarks in the development of biochemistry. Biomolecules: Characteristics and types. Interactions in biological systems: Intra and intermolecular forces, Electrostatic and hydrogen bonds, Disulfide bridges, Hydrophobic and hydrophilic molecules and forces, Water: Hydrogen bonding and structure of water molecule, ionization of water, colligative properties of water, pH, Buffers.

UNIT-2 **(8 Hours)**

Carbohydrates-Structure and functions: Structures and properties of monosaccharides, oligosaccharides and polysaccharides. stereo isomers and structural isomers. Ring structure and muta rotation. Homo and hetro polysaccharides, Muco polysaccharides.

Amino acids & Proteins: Structure and properties of amino acids. Essential and non-essential amino acids, peptide bond and pI values of peptides. Types of proteins and their classification. Different levels of structural organization of proteins, structure of protein (Myoglobin, Hemoglobin and collagen), conjugated proteins.

UNIT-3 **(8 Hours)**

Lipids-Structure and functions: Classification of lipids and their general functions. Essential fatty acids. Hydrolysis of fats, Saponification value, Rancidity of fats, Cholesterol-its structure and biological functions.

Nucleic Acids-Structure and functions: Structure and properties of purine and pyrimidine bases. Nucleosides and nucleotides. Biologically important nucleotides. Vitamins: Role of Vitamins, metals ions, significance.

UNIT-4 **(8 Hours)**

Metabolism & Bioenergetics: Basic concepts Energetics of Metabolic Pathways; Energy Coupling (ATP & NADH);, Anabolism and catabolism, Metabolic pathway databases (KEGG, Reactome etc.), Carbohydrate metabolism: Glycolysis, TCA cycle, Pentose phosphate pathway, Gluconeogenesis, and glycogen metabolism; Electron transport chain and oxidative phosphorylation; **Fat Metabolism:** Beta Oxidation of fatty acids, synthesis of fatty acids.

UNIT-5 **(8 Hours)**

Amino acid metabolism: Biosynthesis of amino acids from intermediates of Citric Acid Cycle & other major pathways. Biodegradation of amino acids: Deamination, transamination. Urea Cycle and its regulation. **Metabolism of Nucleotides:** Purines & Pyrimidines synthesis : de Novo & salvage pathway, Conversion of nucleoside monophosphates to nucleoside triphosphates, Formation of deoxyribonucleotides, Catabolism & salvage of Purine and Pyrimidine nucleotides.

BIOCHEMISTRY (BTT-004)

L:T:P::3:1:0 **Credits-4**

TEXT /REFERENCE BOOKS:

1. Lehninger Principles of Biochemistry 7th edition by Nelson, David L. Cox, Michael M. Lehninger, Albert L. WH Freeman & Co
2. Biochemsitry by Voet, D. and Voet, J.G. John Wiley & Sons Inc.,(2010)
3. Biochemistry by Rastogi, S.C. "Biochemistry" 3rd Edition , Tata McGraw-Hill.(2010)
4. Biochemistry by Satyanarayana, U. and U. Chakerapani, "Biochemistry" Books & Allied (P)Ltd.(2019)

MICROBIOLOGY (BTT-005)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES:

1. To know about scope and development of microbiology
2. To learn about ultrastructure of microbial cell and function
3. To improve knowledge about basic microbiological techniques and microbial nutrition
4. To enrich our knowledge about history, structure and types of virus.

COURSE OUTCOMES

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

1. Get acquainted about the historical perspectives important in the development of microbiology and classify various microorganisms and its application in modern biotechnology
2. Understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes
3. Articulate, select and prepare various culture media and their applications and comprehendthe various methods for identification of unknown microorganisms.
4. Know the various physical and chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement
5. Demonstrate and evaluate the structure and cultivation of virus and its involvement indisease causing.

SYLLABUS

UNIT-I **(8 Hours)**

Scope and recent development in field of microbiology, History of Microbiology: Discovery of microorganism, Spontaneous generation vs Biogenesis, Contribution of Louis Pasteur, Contributionof Koch, Contribution of Lister, Germ theory of fermentation, Contribution of Metchinikoffs and Edward Jenner, Classification of Microorganism, Binomial classification, Two Kingdomclassification, Carl Woese's Three kingdom classification, Whittaker's Five Kingdom classification, Eight kingdom classification, Differences between Eukaryote and Prokaryotes, Method of classification based on 16s RNA, DNA homology

UNIT-II **(8 Hours)**

Morphology and ultra-structure of Prokaryote, Cell shape and size, Cell membrane-structure, composition and properties, Ultra structure of eubacterial and archaebacterial cell wall, Gram- negative and Gram-positive bacteria, Outer membrane of Gram negative bacteria, Capsules- types, composition and function

UNIT-III **(8 Hours)**

Structure and function of flagella, and pili, gas vesicles, carboxysomes, magnetosomes and phycobilisomes, nucleoid, endospores, reserve food materials polyhydroxybutyrate, phosphate granules, Oil droplets, cyanophycin granule sand sulfur inclusions, Bacterial recombination

UNIT-IV **(8 Hours)**

Nutritional types of bacteria, Culture media, Pure culture techniques, Isolation, Maintenance and Preservation methods for pure culture, Sterilizing techniques, Staining Techniques, Cultivation of aerobic and anaerobic bacteria, Microbial Growth kinetics, Batch and continuous cultures, , Synchronous and diauxic growth, Measurement of growth, Factors affecting microbial growth

UNIT-V **(8 Hours)**

Microorganism: Fungi, Yeast, Cyanobacteria and viruses, Differentiating features, morphology,reproduction, classification and cultivation

Virology: History, Structure and cultivation of Virus, Types of envelopes and their compositions, Viral genome, their types and structures, virus related agents (viroids, virusoidsand prions), Multiplication of animal and plant viruses, Cultivation of Virus, Bacteriophage and itslifecycle (Lytic and lysogenic),

MICROBIOLOGY (BTT-005)

L:T:P::3:1:0 **Credits-4**

TEXT /REFERENCE BOOKS:

1. Brocks Biology of Micro-organisms (14th ed) by Michael T, Madigan and John M Martinko, Pearson, 2014
2. Prescott Microbiology (7th ed) by Harley and Kleins McGraw-Hill Higher Education, 2007
3. Microbiology (5th ed) by Michael J. Pelczar, Jr. E.C.S. Chan and Moel R. Krieg, Mc GrawHill Book, Company, 1998

CELL AND MOLECULAR BIOLOGY LAB (BTP-001)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES:

To introduce the hands-on descriptions of most important techniques in molecular biology in order to diagnose the defects in the genetic material, cell structure, function, metabolism and morphology etc with the help of related instruments and devices.

COURSE OUTCOMES:

1. To formulate, analyze and solve a multilevel laboratory problem in cell biology and molecular biology lab.
2. To demonstrate experimental comprehension of Gel electrophoresis and study of mitotic stages of cell.
3. To analyze the separation, isolation of DNA and, find out plant or animal cell structure.
4. To handle various experiments in the area of genomics, Cellular physiology and morphology.
5. To think innovatively and improve the creative skills that are essential for engineers

LIST OF EXPERIMENTS:

1. To prepare an onion peel slide and observe it under microscope.
2. To Study plant and animal cell structure with slide.
3. To Study various stages of mitosis with slides
4. To Study various stages of meiosis with slides
5. To study Polytene chromosome with slides
6. To study cell organelles (prepared slides)
7. Preparation of temporary whole mount (human cheek cells)
8. Preparation of permanent whole mount
9. To determine the melting curve of DNA
10. To determine base composition of DNA
11. Preparation of different stock solutions used in molecular biology (Solutions used in PCR, electrophoresis, DNA isolation, RNA isolation and Protein isolation)
12. Isolation of DNA from human blood
13. Quantification of DNA and RNA through spectrophotometer
14. To perform basic techniques of Agarose gel electrophoresis
15. To perform basic techniques of Polyacrylamide gel electrophoresis

LAB MANNUAL/REFERENCE BOOKS:

1. Gerald Karp, (2015). Karp's Cell and Molecular Biology: Concepts and Experiments – 8th edition, John Wiley & Sons Inc.
2. Comprehensive Laboratory Manual Of Life Sciences By- J. Saxena, Mamta Baunthiyal, I. Ravi, Scientific Publication, 2019

BIOCHEMISTRY LAB (BTP-002)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions of various types of biomolecules, its properties, physical concepts of analytical techniques, Qualitative and Quantitative study of biomolecules etc with the help of related instruments and devices.

COURSE OUTCOMES

1. To formulate, analyze and solve a multilevel laboratory problems in biochemistry and basic analytical tools.
2. To demonstrate experimental comprehension of biomolecules, its properties and handling of analytical devices.
3. To analyze the concept of logic properties, Quantitative and Qualitative estimation of biomolecule in samples .
4. To handle various experiments in the biochemistry, enzymology and analytical field.
5. To think innovatively and improve the data interpretive skills that are essential for engineers.

LIST OF EXPERIMENTS:

1. Introduction to commonly used instruments (pH meter, Spectrophotometer, Centrifuge, Microscopes etc.) and laboratory safety.
2. Preparation of Buffer.
3. Qualitative and Quantitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars: Anthrone and Fehling's test.
4. Qualitative and Quantitative method for amino acid estimation using ninhydrin distinguishing amino from imino acid.
5. Determination of Logic properties (pH value of Lysine by titration).
6. Protein estimation by Biuret and Lowry's methods.
7. To perform UV-visible Spectrophotometric determination of proteins concentration.
8. Protein estimation by Bradford and spectroscopic methods.
9. Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect.
10. Solubility and qualitative test for fatty acid.
11. Determination of acid value of fat/oil
12. Determination of Iodine number of fat/oil
13. Preparation and purification of casein from buffalo milk

LAB MANNUAL /REFERENCE BOOKS:

1. Laboratory Manual for Biotechnology by Verma, Ashish S., Das Surajit & Singh Anchal, S. Chand publication, 2014.
2. Comprehensive Laboratory Manual Of Life Sciences By- J. Saxena, Mamta Baunthiyal, I. Ravi, Scientific Publication, 2019

MICRBIOLOGY LAB (BTP-003)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES:

To introduce the hands-on descriptions of various types of microbes, concept of microbial biotech, microbial physiology, morphology and biochemical characterization of microbes etc with the help of related instruments and devices

COURSE OUTCOMES:

1. To formulate, analyze and solve a multilevel laboratory problems in microbiology lab.
2. To demonstrate experimental comprehension of isolation and preservation of microbes.
3. To analyze the concept of biochemical characterization, various staining techniques and measurement for microorganisms.
4. To handle various experiments in the area of microbiology, cell growth and its cellular physiology.
5. To think innovatively and improve creativity skills those are essential for engineers.

LIST OF EXPERIMENTS:

1. Working and principle of instrument used in the microbiology lab
2. Wrapping of glassware
3. To perform various staining techniques for microbes
4. Microscopic measurement of cell-dimensions of microorganisms.
5. Preparation and sterilization of various culture media (Nutrient Agar, and Nutrient broth , Potato dextrose agar and Potato dextrose broth) for routine cultivation of microorganisms
6. Enumeration, isolation (Pour late, spread plate and Streak plate methods), purification and preservation bacteria from different sources-soil, air, water and milk.
7. Cultivation and identification of fungi from different sources – soil, air and water.
8. Biochemical characterizations such as IMViC tests: Indole production, Methyl-red, Voges–Proskauer and Citrate utilization test, Oxidase test, catalase, Hydrogen sulphide for identification of microorganism
9. To study effect of different parameters on microbial growth (pH, temperature & UV irradiation)
10. Measurement of microbial growth by spectrophotometer
11. Estimation of microbial growth by PCV
12. Estimation of microbial growth by WCW
13. To perform quantitative determination of growth by Plate Count Method.
14. To count total viable cell (TVC) by using Neubauer chamber.
15. To Develop experimental design and troubleshooting skills in Microbiology lab

LAB MANUAL /REFERENCE BOOKS:

1. Lab Manual of Microbiology, Biochemistry and Mol. Biology (1st eds) by J. Saxena, Mamta Baunthiyal, I.Ravi, Scientific Publication, 2015
2. Experiments in Microbiology Plant Pathology and Biotechnology (5th ed) by KR Aneja. New Age International publisher, 2017
3. Practical Microbiology (5th ed) by R C Dubey and D. K. Maheshwari, S. Chand and Company. 2014

INTERNSHIP-I/MINI PROJECT-1 (BTP-004)

L:T:P::0:0:2 **Credits-1**

CYBER SECURITY (CST009)

L:T:P::2:0:0 **Credits-0**

COURSE OBJECTIVES: The educational Objectives of this Course are:

1. To familiarize with network security, network security threats, security services, and countermeasures.
2. To be aware of computer security and Internet security.
3. To study the defensive techniques against these attacks.
4. To familiarize with cyber forensics.
5. To be aware of cybercrime related to mobile and laptops etc.
6. To acquire knowledge relating to Cyberspace laws and Cybercrimes.
7. To understand ethical laws of computers for different countries, Offences under cyberspace and the Internet in India.

COURSE OUTCOMES: On successful completion of the course, the student will:

1. Understand cyber-attacks and types of cybercrimes, and familiarity with cyber forensics
2. Realize the importance of cyber security and various forms of cyber-attacks and countermeasures.
3. Get familiar with obscenity and pornography in cyberspace and understand the violation of the Right to privacy on the Internet.
4. Appraise Cyber laws and how to protect themself and, ultimately, the entire Internet community from such attacks.
5. Elucidate the various chapters of the IT Act 2008 power of the Central and State Governments to make rules under IT Act 2008.

UNIT – I: Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, the motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., CIA Triad

UNIT – II: Cyber Forensics: Introduction to cyber forensic, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

UNIT – III: Cybercrime (Mobile and Wireless Devices): Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops and desktop.

UNIT – IV: Cyber Security (Organizational Implications): Introduction cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations.

Cybercrime and Cyber terrorism: Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes, the psychology, mindset and skills of hackers and other cybercriminals.

UNIT – V: Cyberspace and the Law &Miscellaneous provisions of IT Act.: Introduction to Cyber Security Regulations, International Law. The INDIAN Cyberspace, National Cyber Security Policy. Internet Governance – Challenges and Constraints, Computer Criminals, Assets and Threats. Other offences under the Information Technology Act in India, The role of Electronic Evidence and miscellaneous provisions of the IT Act.2008.

TEXTBOOKS:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

REFERENCE BOOKS:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.
3. Debby Russell and Sr. G.T Gangemi, "Computer Security Basics (Paperback)", 2ndEdition, O' Reilly Media, 2006.
4. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New Delhi, 2006.
5. Cyberspace and Cybersecurity, George Kostopoulos, Auerbach Publications, 2012.
6. Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes, Second Edition, Albert Marcella, Jr., Doug Menendez, Auerbach Publications, 2007.
7. Cyber Laws and IT Protection, Harish Chander, PHI, 2013.

BIOPHYSICS & STRUCTURAL BIOLOGY (BTT-006)

L:T:P: 3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To define the basics and scope of biophysics.
2. To understand the importance of various types of non-covalent interactions in biological system.
3. To be familiar with structural aspects of biomolecules - proteins and nucleic acids.
4. To understand the structure and function of the biological membrane, muscular and neural system.

COURSE OUTCOMES

After completion of the course, the students will be able to:

1. Analyze the various forces responsible for molecular structures of biological system.
2. Explain different levels of conformation in biomolecules.
3. Understand the basics and significance of cellular permeability.
4. Understand the dynamics of muscular and neural system.

SYLLABUS

UNIT-I **(8 Hours)**

Introduction and Scope of Biophysics, Biophysics at macroscopic, microscopic level and at themolecular level, Biophysical Chemistry: structure of atoms, molecules; energy, structure ofatoms and molecules, elementary quantum mechanics, stereochemistry, molecular orbitals &chirality.

UNIT-II **(8 Hours)**

Van der Waals radii of atoms–contact distance criteria, Noncovalent forces determining biopolymer structure: Dispersion forces, Electrostatic interactions, Van der Waals interactions, Hydrogen bonds, Hydrophobic interactions. Distortional energies. Description of various interactions by potential functions, Conformational energy

UNIT-III **(8 Hours)**

Configuration of DNA, RNA, Isomers of nucleotides, Glycosidic bond rotation, base stacking, Proteins: zwitter ionic properties & amino acids and titration curves, peptidebonds, disulfide cross links, Ramachandranplot, alpha-helix, beta-sheet, Helix-coil transition, Protein folding.

UNIT-IV **(8 Hours)**

Muscular System: Molecular structure of muscle - actin, myosin, troponin, tropomyosin, Physico & biochemical events in muscle contraction, Mechanical properties of skeletal muscles, Mechanical model of muscle, Mechanical events of muscle contraction, Force velocity, Power velocity and Tension, Length relationship curves.

UNIT-V **(8 Hours)**

Membrane potentials: origins of membrane potential, electrochemical potentials, Gibbs-Donnan Equilibrium, Nernst equation, Goldman equation. Membrane transport; diffusion, Facilitated Diffusion, Membrane transport proteins, Carrier mediated transport, Channel mediated transport. Neurons, synapsis, Action potential and its propagation through nerve Fiber. Photo chemical events of vision. Neural networks

TEXT /REFERENCE BOOKS:

1. Biological Physics: Energy, Information, Life by Philip C. Nelson; M. Radosavljević; S. Bromberg; David S. Goodsell. NewYork : W. H. Freeman and Company, (2014)
2. Biophysical Chemistry (Vol. 1 & 3) by C. R. Cantor and P. R. Schimmel. W.H. Freeman (1980).
3. Biophysics (Second edition) by Vasantha Pattabhi, N. Gautham. Kluwer Academic Publishers (2009)
4. Biophysics: An introduction by CHRISTIAAN SYBESMA. Kluwer Academic Publishers, (1995)
5. The structure of biological membranes (2nd ed.) by P. L. Yeagle. CRC Press, (2004)

BIOPROCESS ENGINEERING (BTT-007)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To introduce the engineering principles of bioprocesses including growth kinetics, media requirement, bioreactor components and control system, concept and methods of sterilization.
2. To study the stoichiometry and energetics of cell growth and product formation
3. To evaluate the kinetics and mechanism of microbial growth.
4. To know the importance of diffusion and mass transfer in bioreactor
5. To learn the bioprocess modelling and simulation.

COURSE OUTCOMES

After completion of the course

1. Students will develop the skills to understand the theory and practice of experiments related to bioprocess engineering
2. Students can apply the knowledge gained in bioprocess industries.
3. Students can solve problems related to cell growth kinetics and mass transfer in bioreactors.
4. Students will be able to illustrate modelling and simulation in process industries

SYLLABUS

UNIT-I **(8Hours)**

Overview of bioprocess engineering, historical development in bioprocess engineering, Concept of material balance: types of material balance, growth stoichiometry and elemental balance, electron balance, maintenance coefficient and yield concept, screening and improvement of Industrial important microorganism.

UNIT-II **(8Hours)**

Principle of microbial nutrition, formulation of culture media, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents, medium optimization. Microbial growth kinetics: growth, substrate utilization and production kinetics in Batch, Continuous and Fed-batch processes.

UNIT-III **(8Hours)**

Sterilization: concept and methods. Type of Sterilizations, Batch heat sterilization of liquids, Continuous heat sterilization of liquids, Sterilization of air: Methods & Mechanism, Design of depth filter and estimation of its efficiency. Bioreactors: components and control of major process parameters. Types of bioreactors: CSTR, Airlift, Fluidized bed, plug flow reactor. Concept of ideal and non-ideal reactors

UNIT-IV **(8Hours)**

Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor. Concept of scale up and scale down in bioreactors. Design of bioreactors

UNIT-V **(8Hours)**

Industrial production of Penicillin, Streptomycin, Tetracycline and other Antibiotics, Organic solvents, acetone, ethanol, butanol, Organic acids: lactic acid, citric acid and acetic acid, Enzymes (Proteases, Lipases and alpha-amylase), Amino acids (L- glutamic acid, phenylalamine and L-lysine) and monoclonal antibodies. Introduction to Modelling and simulation of bioprocess.

Educational activity: Industrial visit of students to bioprocess based industries.

BIOPROCESS ENGINEERING (BTT-007)

L:T:P::3:1:0 **Credits-4**

TEXT /REFERENCE BOOKS:

1. Bioprocess Engineering, by Michael L. Shuler, Fikret Kargi, Matthew DeLisa 3rd Edition, PrenticeHall International Series. (2017)
2. Principles of Fermentation technology, by Peter Stanbury third edition,
3. Butterworth-Heinemann. (2015)Bioprocess Engineering Principles, by Pauline M Doran 2nd Edition, Academic Press, USA.(2013)
4. Biochemical Engineering Fundamentals,by James E Bailey & David F Ollis. 2nd Edition, McGraw Hill Book Co.-Singapore

GENETIC ENGINEERING & RECOMBINANT DNA TECHNOLOGY (BTT-008)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To know basics of recombinant DNA Technology
2. To enrich knowledge about different techniques used in recombinant DNA Technology.
3. To acquire knowledge of solving human health problems through rDNA Technology

COURSE OUTCOMES

On successful completion of this course, students will able to

1. Acquire the knowledge about common tools of rDNA for human welfare
2. Apply the knowledge of rDNA biotechnology for counseling and curing of complex genetic diseases/disorders
3. Develop the new strategies for bio-entrepreneurship development through r DNA technology

SYLLABUS

UNIT-I **(8 Hours)**

Basic Principles of Gene Cloning and DNA Analysis: Introduction, History, Steps involved in Recombinant DNA Technology.

Enzymes involved in manipulation of DNA: Restriction Endonuclease, Restriction- modification system, Patterns of DNA cutting by restriction enzymes, Alkaline phosphatase, Polynucleotide kinase, DNA Ligases, Terminal deoxy-nucleotidyl transferase, S1 nuclease, DNA Polymerase, Types of Polymerases: Kornberg Polymerases, Klenow polymerases, Taq-DNA Polymerases, Sequenase, Reverse transcriptase, RNases, Ribonuclease.

UNIT-II **(8 Hours)**

Cloning Vectors: Vectors, Characteristics of Vector, Plasmid based cloning vector: pBR322, pUC, screening and selection of recombinant clones, Col E1 plasmid, F plasmid, R plasmid, cosmids, Shuttle Vector, Bacteriophage vectors - Lamda phage, Phagemids, Yeast artificial Chromosomes (YAC), Bacterial artificial chromosomes (BAC), Shuttle vectors, Expression vectors.

UNIT-III **(8 Hours)**

Transformation methods, Gene transfer techniques: Biological, Chemical, Physical or Mechanical method, Ti plasmid, Agrobacterium mediated gene transformation.

UNIT-IV **(8 Hours)**

Molecular markers - RAPD, RFLP, Primer Designing: Properties of a good primer, Online tools for primer designing: Primer-BLAST, Principle and applications of PCR, DNA sequencing: Basic Concepts.

UNIT-V **(8 Hours)**

Construction of genomic and cDNA libraries, Safety regulations in recombinant DNA, Ethical issue involving in rDNA Technology, Role of Recombinant DNA Technology to improve life: Recombinant Insulin, Growth Hormone.

TEXT /REFERENCE BOOKS:

1. T. A. Brown, (2016). Gene Cloning & DNA Analysis: An Introduction, VII Edition, WILEY Blackwell.
2. Benjamin Lewin, (2017). Gene XII, Oxford University Press, UK.
3. Primrose, S.B. and Twyman, R.M. (2014). Principles of Gene Manipulation and Genomics - 7th Edition.Blackwell Publishing Company.
4. Satyanarayana. U, (2018). Biotechnology 12th Edition, Books and Allied (p) Ltd.

IMMUNOLOGY (BTT-009)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To know the concept of immune-system and its implication for health and diseases.
2. To understand the structure, functions and properties of different cell types and organs that comprises the immune system.
3. To develop knowledge about the principles and applications of immune-assays for evaluating immune-status.
4. To comprehend the range of immunological agents and the strategies that may be used to prevent and combat infectious diseases.

COURSE OUTCOMES

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

1. Articulate the basics of immunology and understand various characteristics of antigens.
2. Learn about the mechanisms by which a human body interacts with a pathogenic microbe & eliminates it.
3. Select and use immunoassay techniques in routine diagnosis, research for human health
4. Learn principle and types of vaccines, autoimmunity and transplantation
5. Identify allergic reaction, and its diagnosis for human health and assess health problems with an immunological background

SYLLABUS

UNIT-I **(8 Hours)**

Immune system and Immunity; History of immunology, Innate and adaptive immunity, Determinants of innate immunity: species and strains, individual differences, influence of age, Herd immunity, Immune responses- innate immunity, mechanism of innate immunity, acquired immunity, Active and passive immune responses, Compositionand function of cells and organs involved in immune system.

UNIT-II **(8 Hours)**

Introduction to Immunotechnology; Antigen, types and properties of antigen, Antigenicity vs Immunogenicity, factors that influence the immunogenicity, parameters of immunogenicity, Haptens, Super antigen, isopecificity, Heterophile specificity and autospecificity.

UNIT-III **(8 Hours)**

Cellular and humoral immune responses, activation and function of T and B cells, Fine structure and function of immunoglobulin and Different types of Immunoglobulin, Monoclonal antibody (MAB) and Polyclonal antibody, Hybridoma technology, production of monoclonal antibody, Major Histocompatibilty Complex, Complement System, Vaccine and its role in immunization, Vaccine schedule, Immunization, types of immunization, Rationale of immunization, role of adjuvant in immunization, Hazards of immunization, Dosage, age of commencement.

UNIT-IV **(8 Hours)**

Antigen-Antibody interaction; affinity, cross reactivity, specificity, Precipitation, mechanism of precipitation, application of precipitation, Agglutination and its application, Complement: Direct complement fixation test and indirect complement fixation test, Neutralization test; Immuno assays RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence

UNIT-V **(8 Hours)**

Hypersensitivity reaction, Antibody-mediated-Type-1, Anaphylaxis-Type-II, Antibody dependent cell cytotoxicity Type III, Immune complex mediated reactions Type IV, cell mediated hypersensitivity reactions, Defects inimmune system, Transplantation and tumor immunology, Autoimmunity, criteria and causes of autoimmune diseases.

IMMUNOLOGY (BTT-009)

L:T:P::3:1:0 **Credits-4**

TEXT /REFERENCE BOOKS:

1. Kubey Immunology (7thed) by Thomas J Kindt, Richard A Goldsby, Barbara Anne Osborne and *JanisKuby*W.H. Freeman, New York, *2013)*
2. Roitt's essential of Immunology (13thed) by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M.Roitt, Wiley-Black, 2017
3. The elements of Immunology, (1sted) by F. H. Khan, Pearson Education, 2009

BIOPROCESS ENGG. LAB (BTP-005)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions for various types of microbes, concept of microbial biotech, bioreactor and it's processing and monitoring etc with the help of related instruments and devices.

COURSE OUTCOMES

1. To formulate, analyze and solve a multilevel laboratory problem in bioprocess engineering lab.
2. To demonstrate experimental comprehension of isolation, preservation of microbes and fermentation process for various products.
3. To analyze the concept of KLa in bioreactor and bioreactor processing and monitoring in lab.
4. To handle various experiments in the area of Microbial technology, Bioprocess and Bioreactor engineering.
5. To think innovatively and improve data interpretation skills those are essential for engineers

List of Experiments

1. To study batch growth curve in shake flask fermenter

2. Determination of Monod Kinetics in batch culture.

3. To perform enzyme purification by ammonium sulphate

4. To study the various parameters those, affect the kinetics of alpha-amylase catalyzed hydrolysis of starch.

5. To demonstrate the use of microorganisms in food processing by using yogurt as an example.

6. Ethanol production and its estimation.

7. To perform Media Sterilization in the Bioreactor

8. To perform Thermal deactivation kinetics

9. To perform KLa determination in the Bioreactor

10. Estimation of lactic acid in curd.

11. Study of different parts of bioreactor.

12. Determination of mixing time in bioreactor.

13. Determination of residence time distribution in bioreactor.

14. Determination of mixing time in stirred vessel with both Newtonian and non-Newtonian fluids.

15. Determination of immobilized enzyme kinetics in packed bed reactors

TEXT /REFERENCE BOOKS

1. Laboratory Manual for Biotechnology by Verma, Ashish S./ Das Surajit & Singh Anchal, S. Chand publication, 2014.
2. Comprehensive Laboratory Manual Of Life Sciences By- J. Saxena, Mamta Baunthiyal, I. Ravi, Scientific Publication, 2019.
3. Laboratory Bioprocess Technology by AN Shukla, Discovery publishing house, 2013.
4. www.vlab.com

GENETIC ENGINEERING & RECOMBINANT DNA TECHNOLOGY LAB (BTP-006)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions of most important techniques in RDT in order to diagnose the defects in the genetic material, Gel electrophoresis, Primer designing, Polymerase chain reaction and DNA Transformation etc in laboratory.

COURSE OUTCOMES

1. To formulate, analyze and solve a multilevel laboratory problem in Recombinant DNA technology lab.
2. To demonstrate experimental comprehension of Gel electrophoresis and DNA transformation techniques.
3. To analyze the separation, isolation of DNA from samples and, handling PCR in lab .
4. To handle various experiments in the area of genomics, Computation biology and Genetic engineering.
5. To think innovatively and improve the creative skills that are essential for engineers.

LIST OF EXPERIMENTS

1. To perform Isolation of Genomic DNA from Bacteria.
2. To perform Isolation of plasmid DNA from *E. coli*.
3. To perform Agarose gels electrophoresis of nucleic acid.
4. To perform Isolation of RNA from plant and microbes.
5. To perform Primer Designing
6. Polymerase chain reaction
7. To perform DNA finger printing
8. To perform Restriction endonuclease digestion of chromosomal and plasmid DNA
9. Purification of digested DNA by column purification
10. Ligation of DNA fragment with cloning vector
11. Competent cell production
12. To perform Transformation of competent cells with pUC19 and pUC19 recombinants
13. Transformation of competent cells with plasmid DNA
14. Transformation of *E. coli* with recombinant vector

LAB MANUAL/REFERENCE BOOKS

1. Gerald Karp, (2015). Karp's Cell and Molecular Biology: Concepts and Experiments – 8th edition, John Wiley & Sons Inc
2. Comprehensive Laboratory Manual of Life Sciences By- J. Saxena, Mamta Baunthiyal, I. Ravi, Scientific Publication, 2019

IMMUNOLOGY LAB (BTP-007)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions of various types of clinical immunological test, serological test, Pathological diagnosis, immunological assay and its staining techniques with the help of related instruments and devices.

COURSE OUTCOMES

1. To formulate, analyze and solve a multilevel laboratory problem in immunology lab.
2. To demonstrate experimental observation for clinical diagnosis of disease and blood groups in patients.
3. To analyze the concept of applications of immunological tech and types of antigen antibody interaction in lab.
4. To handle various experiments in the immunological assay, Clinical and pathological microbiology.
5. To think creative and improve scientific and observational skills those are essential for engineers

LIST OF EXPERIMENTS:

1. Identification of blood groups.
2. To separate the plasma and serum from blood sample
3. Identification of cells in a blood smear
4. Identification of various immune cells by morphology – Leishman staining, Giemsa staining
5. Testing for Typhoid antigens by Widal test
6. Test of Hepatitis B virus
7. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP
8. Rheumatoid Factors: Slide latex Agglutination test
9. To perform malaria test
10. To Perform Hemoglobin test
11. To perform single radial immunodiffusion by Mancini's technique
12. To perform double immunodiffusion (DID) by Ouchterlony's method
13. To perform enzyme-linked immunosorbent assay (ELISA) by direct method

TEXT /REFERENCE BOOKS

1. Detrick, Barbara, Robert G. Hamilton, and John L. Schmitz, eds. Manual of molecular and clinical laboratory immunology. John Wiley & Sons, 2020.
2. Brousseau, Pauline, Yves Payette, Helen Tryphonas, Barry Blakley, Herman Boermans, Denis Flipo, Michel Fournier et al. Manual of immunological methods. CRC press, 2021.

Python Programming (CST005)

L:T:P::2:0:0 **Credits-0**

COURSE OBJECTIVES: The educational Objectives of this Course are:

1. Apply the principles of python programming.
2. Write clear and effective python code.
3. To perform file operations to read and write data in files.
4. To create applications using Python Programming.

COURSE OUTCOMES: On successful completion of the course, the student will:

1. Develop essential programming skills in computer programming concepts like data types.
2. Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.
3. Illustrate the process of structuring the data using lists, tuples, and dictionaries.
4. Demonstrate using built-in functions and operations to navigate the file system.
5. Interpret the concepts of modules and user-defined functions in Python.

UNIT – I: Introduction and Syntax of Python Program: Features of Python, Interactive, Object-oriented, Interpreted, platform-independent, Python building blocks -Identifiers, Keywords, Indention, Variables, Comments, Python environment setup – Installation and working of IDE, Running Simple Python scripts to display a welcome message, Python variables.

Python Data Types: Numbers, String, Tuples, Lists, Dictionary. Declaration and use of datatypes, Built-in Functions.

UNIT – II: Python Operators and Control Flow statements: Basic Operators: Arithmetic, Comparison/ Relational, Assignment, Logical, Bitwise, Membership, Identity operators, Python Operator Precedence.

Control Flow: Conditional Statements (if, if...else, nested if), Looping in python (while loop, for loop, nested loops), loop manipulation using continue, pass, break, else.

UNIT – III: **Data Structures in Python: String:** Concept, escape characters, String special operations, String formatting operator, Single quotes, Double quotes, Triple quotes, Raw String, Unicode strings, Built-in String methods.

Lists: Defining lists, accessing values in lists, deleting values in lists, updating lists, Basic List Operations, and Built-in List functions.

Tuples: Accessing values in Tuples, deleting values in Tuples, and updating Tuples, Basic Tuple operations, and Built-in Tuple functions.

Sets: Accessing values in Set, deleting values in Set, and updating Sets, Basic Set operations, Built-in Set functions.

Dictionaries: Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary, Basic Dictionary operations, Built-in Dictionaries functions.

UNIT – IV: Python Functions, modules, and Packages: Use of Python built-in functions (e.g., type/data conversion

functions, math functions etc.),

user-defined functions: Function definition, Function call, function arguments and parameter passing, Return statement, **Scope of Variables:** Global variable and Local Variable.

Modules: Writing modules, importing modules, importing objects from modules, Python built-in modules (e.g., Numeric, mathematical module, Functional Programming Module), Packages.

UNIT – V: File Handling: Opening files in different modes, accessing file contents using standard library functions, Reading, and writing files, closing a file, Renaming, and deleting files, File related standard functions.

TEXTBOOKS:

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3", 1st Edition, CreateSpace Independent Publishing Platform, 2016.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015.
3. Ch Satyanarayana, "Python Programming", 1st Edition, universities press (India) private limited 2018.

REFERENCE BOOKS:

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, "Core Python Applications Programming", 3rd edition, Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, "Data Structures and Algorithms in Python",1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176
5. Reema Thareja, "Python Programming using problem-solving approach", Oxford university press, 2017.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY
(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)
Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

B.TECH
(Biotechnology)
3RD Year

Effective From – Session 2024-25

Semester-V

S. No.	Subject Codes	Subject Name	Periods			Sessional Exam			ESE		Subject Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1.	BTT 010	Bioinformatics	3	1	0	30	20	50	100		150	4
2.	BTT 011	Enzyme Technology	3	1	0	30	20	50	100		150	4
3.	BTT 012	Cell & Tissue Culture Technology	3	1	0	30	20	50	100		150	4
4.	BTT051-054	Departmental Elective–1 BTT 051: Genetics BTT 052: Biodiversity and Conservation BTT 053: Bioanalytical Technology BTT 054: Biomaterials and Tissue Engineering	3	0	0	30	20	50	100		150	3
5.	BTT055-058	Departmental Elective–2 BTT 055: Food Biotechnology BTT 056: Herbal Biotechnology BTT 057: Agriculture Biotechnology BTT 058: Animal Biotechnology	3	0	0	30	20	50	100		150	3
6.	BTP 008	Bioinformatics Lab	0	0	2		25	25		25	50	1
7.	BTP 009	Enzyme Technology Lab	0	0	2		25	25		25	50	1
8.	BTP 010	Cell & Tissue Culture lab	0	0	2		25	25		25	50	1
9.	BTP 011	Mini Project-II or Internship-II*	0	0	2			50			50	1
10.	AHT009/ AHT010	Constitution of India / Essence of Indian Traditional Knowledge	2	0	0	15	10	25	50			
11.	GP05	General Proficiency						50				
		Total	**17**	**3**	**8**						**950**	**22**
		Minor Course (Optional)	3	1	0	30	20	50	100			**4**
	*The Mini Project-II or Internship-II (4-6 weeks) conducted during summer break after IV semester and will be assessed during V semester											
	MOOCs course											

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week, **CT**-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance, **PS**-Practical Sessional Marks, **ESE**-End Semester Examination, **TE**- Theory Examination Marks, PE- Practical External Examination Marks

Semester-VI												
S. No.	**Subject Codes**	**Subject Name**	**Periods**			**Sessional Exam**			**ESE**		**Subject Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1.	BTT 013	Downstream Processing	3	1	0	30	20	50	100		150	4
2.	BTT 014	Environment Biotechnology	3	1	0	30	20	50	100		150	4
3.	BTT 015	Plant Biotechnology	3	1	0	30	20	50	100		150	4
4.	BTT059-062	Departmental Elective-3 BTT 059: Genomics & Proteomics BTT 060: IPR, Bioethics &Biosafety BTT 061: Mass Transfer BTT 062: Medical Diagnostic Techniques	3	0	0	30	20	50	100		150	3
5.	XXX-0XX	Open Elective-1#	3	0	0	30	20	50	100		150	3
6.	BTP 012	Down Stream Processing Lab	0	0	2		25	25		25	50	1
7.	BTP 013	Environment Biotech Lab	0	0	2		25	25		25	50	1
8.	BTP 014	Plant Biotech Lab	0	0	2		25	25		25	50	1
9.	AHT010/AHT009	Essence of Indian Traditional Knowledge / Constitution of India	2	0	0	15	10	25	50			
10.	GP06	General Proficiency						50				
		Total	**17**	**3**	**6**						**900**	**21**
		Minor Course(Optional)	3	1	0	30	20	50	100			**4**
		Mini Project-III or Internship-III*	To be completed at the end of VI semester (during Summer Break) & and will be assessed during VII semester									
MOOCs course												
Select open elective subject from other Departments.												

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week,
CT-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance,
PS-Practical Sessional Marks, **ESE**-End Semester Examination, **TE-** Theory Examination Marks,
PE- Practical External Examination Marks
***Open Elective**-AHT011-Total Quality Management or AHT012-Managing e-commerce and digital communication or AHT013-Industrial Safety and Hazard Management

BIOINFORMATICS (BTT-010)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To acquire knowledge how bioinformatics data is stored and organized
2. To explain how to locate and extract data from key bioinformatics databases and resources
3. To describe the methods of sequencing
4. To describe various algorithms for sequence alignment and protein modelling.
5. To explain the concept and methods of gene prediction.

COURSE OUTCOMES

After successfully completing this course, students will be able to:

1. On the completion of this course students shall have knowledge to identify, adapt and develop in silicon models appropriate to the specific study of different biological projects.
2. The students will be familiar with the use of bioinformatics software, tools in their area of research.

SYLLABUS

UNIT-I **(8 Hours)**

Introduction to Bioinformatics, Goals, Scope, Applications in Biological Science, Medicine and Limitations, Databases, types of biological databases (primary, Secondary and specialized) Nucleotide sequence databases (EMBL, Gene Bank, DDBJ), protein sequence database (Swiss prot, PIR), Protein Structure Database (PDB,SCOP,CATH), other databases Pfam, EST, TFB sites, PROSITE,KEGG, Data Retrieval with Entrez, SRS, DBGET.

UNIT-II **(8 Hours)**

Principle of DNA sequencing (Chemical chain termination, dideoxy chain termination method, automated sequencer), Protein sequencing (Edmand degradation method), sequence submission to various databases.

UNIT-III **(8 Hours)**

Sequence alignment: Pair wise and multiple sequence alignment, dynamic programming, Scoring matrix, gap penalty, Sequence alignment algorithm (FAST, BLAST, Needleman and Wunsch, Smith Waterman), Amino acid substitution matrices (PAM BLOSUM).

UNIT-IV **(8 Hours)**

Protein structure prediction (Chou Fasman method): Secondary and tertiary structures, Homology Modelling: Template recognition and initial alignment, Alignment correction, Backbone generation, Loop modelling, Side-chain modelling, Model optimization, Model validation, Threading , ab initio method, Protein-protein interaction ,Protein-ligand interaction, Protein-DNA interaction, Prediction of binding cavities.

UNIT-V **(8 Hours)**

Gene prediction, Gene prediction tools (Genscan, Grail), File format converter tool (BABEL, Read Seq),visualization tools (Rasmol, Pymol, CHIME), drug designing/ discovery.

TEXT /REFERENCE BOOKS:

1. Bioinformatics: Principles and applications (1st edition) by Ghosh and Mallick, Oxford university press,(2015).
2. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (Methods of Biochemical Analysis),(2nd edition) by Andreas D Boxevanis, Wiley–Blackwell, (2001).
3. Bioinformatics: Volume I: Data, Sequence Analysis, and Evolution (Methods in Molecular Biology),(3rdedition) by Jonathan M. Keith, Humana press, (2017)

ENZYME TECHNOLOGY (BTT-011)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To introduce the concept of enzymology and significance of enzymes.
2. To integrate the practical aspects of enzymology with the kinetic theories of enzymes.
3. To provide a mechanistic overview of enzyme activity and catalysis.
4. To learn methods of immobilization and know its importance.
5. To know industrial application of free and immobilized enzymes.

COURSE OUTCOMES

After completion of the course

1. Students will know the significance of enzymes in biological system and its use in industries.
2. They can illustrate enzyme kinetics, active sites and different types of enzyme catalysis.
3. The student will develop skills to carry on lab experiments related to the subjects such as to plan and execute an enzyme assay; to analyse enzyme kinetic data; to analyse kinetic inhibition data and to determine the mechanism of inhibition.
4. The students will be prepared confidently and competently to work with enzyme systems in both Academia and Industry

SYLLABUS

UNIT-I **(8 Hours)**

Introduction to enzymes: Brief history of enzymes, nomenclature and classification of enzymes. Chemical nature of Enzymes: amino acids, the building blocks of protein, Levels of protein Structure: Primary, secondary, tertiary and quaternary structure. Specificity of Enzymes: Types of specificity, the Koshland "induced fit" hypothesis, Strain or transition – state stabilization hypothesis.

UNIT-II **(8 Hours)**

Enzyme Catalysis and Kinetics: Factors affecting the rate of chemical reactions, kinetics of uncatalyzed chemical reactions, kinetics of enzyme-catalyzed reaction, methods for investigating the kinetics of enzyme-catalyzed reactions, nature of enzyme catalysis, inhibition of enzyme activity enzyme inhibition-competitive, non-competitive, and uncompetitive, allosteric enzymes and metabolic regulation.

UNIT-III **(8 Hours)**

The Investigation of Active Site Structure and Chemical nature of Enzyme Catalysis: The identification of binding sites and catalytic site, three-dimensional structure of active site, mechanism of catalysis, mechanism of reaction catalyzed by enzyme without cofactors, metal- activated enzyme and metalloenzyme, coenzymesin enzyme catalyzed reactions.

UNIT-IV **(8 Hours)**

Immobilization of Enzymes: Concept, methods of immobilization, Kinetics of immobilized enzymes, effect ofsolute partition and diffusion on kinetics of immobilized enzymes, use of immobilized enzymes. Enzyme reactors.

UNIT-V **(8 Hours)**

Industrial uses of enzymes: Industrial enzymes: Sales value of industrial enzymes, traditional (non-recombinant) sources of industrial enzymes. Enzyme Engineering: Prediction of enzyme structure, design and construction of novel enzymes. Enzyme database search (ExPASy-ENZYME, BRENDA etc.)

TEXT /REFERENCE BOOKS:

1. Enzymes by Palmer (2001): Horwood Publishing Series.
2. Fundamentals of Enzymology by Price and Stevens (2002): Oxford University Press.
3. Enzyme Technology by Helmut uhling (1998): John Wiley
4. Introduction to Proteins Structure by Branden and Tooze (1998): Garland Publishing Group.

CELL & TISSUE CULTURE TECHNOLOGY (BTT-012)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To improve knowledge of and expertise in animal and plant tissue culture theory and practice with their roleand applications in biotechnology and biochemical research.
2. To learn about media preparation, sterile techniques, aseptic handling, initiation and routine maintenance of cells in culture, common contaminants of plant and animal cell culture.
3. To improve knowledge about the applications of cell culture technology e.g. somatic cell and protoplast fusion; Hybridoma technology.

COURSE OUTCOMES

On successful completion of this course, you should be able to:

1. Explain major components of cell and tissue culture media, e.g. minerals, growth factors, hormones, and what governs the choice of components.
2. Prepare and optimize media for different species and cell lines, without the aid of texts.
3. Perform the common cell culture techniques, e.g. callus culture, Embryo culture and embryogenesis in plants, culture of animal cells.
4. Demonstrate knowledge of cell lines used in mammalian tissue culture, their origins and applications.
5. Competently perform laboratory procedures and demonstrate practical application and conceptual knowledge of cell and tissue culture for biotechnology investigations and applications

SYLLABUS

UNIT-I **(8 Hours)**

Historical background and terminology used in cell & tissue culture, Basic techniques of cell and tissue culture,Tissue culture media-its constituents, selection and preparation, Properties of media, Basic aseptic techniques used in tissue culture, Natural media, synthetic Media (with Serum & Serum free media), complex media.

UNIT-II **(8 Hours)**

Cell and suspension culture: isolation of single cell, suspension cultures, Primary cell culture, Disaggregation Techniques, isolation, propagation, Cell Lines: Development, routine maintenance and characterization of cell lines,immortalization of cell lines.

UNIT-III **(8 Hours)**

Somatic embryogenesis, Factors affecting somatic embryogenesis and organogenesis in plants, somaclonal and other variations, Zygotic embryo culture, Micropropagation and cloning of plants, Production of pathogen free plants, applications of micro propagation in agriculture, horticulture & forestry.

UNIT-IV **(8 Hours)**

Somatic Hybridization: Fusogens, basis of somatic hybridization technology, Protoplast Isolation and culture, fusion of protoplast, Haploid Production: Introduction, Techniques, factors affecting androgenesis, ontogeny of androgenic haploids, plant regeneration from pollen embryos, gynogenisis

UNIT-V **(8 Hours)**

Contamination and cytotoxicity: Sources and types of microbial contamination, Monitoring: Viability assay, Survival assay and transformation assay, germplasm storage: Long term storage, short or medium term storage, cellbanks, transporting cells, storage of hybridoma cells, Productions of monoclonal antibodies.

CELL & TISSUE CULTURE TECHNOLOGY (BTT-012)

L:T:P::3:1:0 **Credits-4**

TEXT /REFERENCE BOOKS:

1. Plant Tissue Culture: Theory and Practise (A revised edition) by S.S. Bhojwani and M.K. Razdan., Elsevier.
2. Cell and Tissue Culture: Laboratory Procedures in Biotechnology by Alan Doyle, J. Bryan Griffiths, WileyPublication,1998.
3. Plant Cell Culture: A practical approach byDixon, R. A, Oxford Press,1985.
4. Elements of Biotechnology by P.K. Gupta, Rastogi Publications, Meerut.
5. Introduction to Plant biotechnology (2nd Ed) by H.S. Chawla, Science Publishers, 2002.

DEPARTMENTAL ELECTIVE – I

GENETICS (BTT-051)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To teach basic concepts of Genetics
2. To teach student Principles of heredity along with computational aspects of genetics
3. To get knowledge of Genome
4. To get knowledge of linkage and mapping
5. To make students aware about importance and applications of Genetics

COURSE OUTCOMES

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

1. Know basic issue of genetics and their relevance
2. Get acquaint basics of heredity and its transmission
3. Know the knowledge of chromosome and genome
4. Get knowledge of linkage chromosome and gene mapping
5. Develop strategies for creating awareness about population genetics, evolution disorder and their counseling

SYLLABUS

UNIT-I **(8 Hours)**

Heredity, Historical Perspectives: Definition-of genetics; Origin of life; spontaneous generation: Preformation; Inheritance of acquired characters; Pangenesis; Germplasm theory; Early Ideas on reproduction; Basics of data science in Genetics

UNIT-II **(8 Hours)**

Principles of Heredity and Variation: Mendel and his experiments, mono hybrid crosses, incomplete dominance and co-dominance, dihybrid crosses, multiple alleles (blood group systems), epistasis, lethal genes, Probability in prediction and analysis of genetic data, Pedigree analysis. Genes and Chromosomes: General features of chromosomes, cell division, sexual reproduction. Chromosomal theory of inheritance, sex determinations-linked, sex-limited and sex-influenced inheritance, Variation in chromosome number and structure

UNIT-III **(8 Hours)**

Molecular organization of chromosomes: Genome size and evolutionary complexity, supercoiling of DNA, structure of bacterial chromosome, structure of eukaryotic chromosome. Gene Mutation and DNA Repair: Chromosomal changes and gene mutations, types of mutations, consequences of mutations, occurrence and causes of mutations

UNIT-IV **(8 Hours)**

Gene Linkage and Chromosome Mapping: Linkage and recombination of genes in a chromosome, crossing over and genetic mapping, gene mapping by 2-point and three point test crosses. Somatic Cell Genetics: Somatic cell hybrids production and gene mapping.

UNIT-V **(8 Hours)**

Population Genetics and Evolution: Allele frequencies and genotype frequencies, random mating and Hardy-Weinberg principle. Inbreeding. Genetics and evolution (Mutation and migration, natural selection, random genetics drift). Genetic disorders and genetic counseling:, Case studies of genetic deformities, Applications of genetics, eugenics. Quantitative Genetics: Quantitative inheritance, causes of variation.

TEXT /REFERENCE BOOKS:

1. Genetics: Analysis of Genes and Genomes. 5th Ed. (2001) Hartl, D.L. and Jones, E.W., Jones and Bartlet Publishers, Boston.
2. Fundamentals of Genetics.2010. B.D. Singh Kalyani Publishers (Pvt) Ltd.Ludhiana.
3. Genetics: Analysis and Principles. (1999) Brooker, R.J.McGraw Hill, NewYork.
4. Principles of Genetics (2004). Hossain and Basu. Books and Allied(P) Ltd.

BIODIVERSITY AND CONSERVATION (BTT-052)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVE

1. To teach students about biodiversity of the Globe and mother Earth
2. To create awareness among students about the natural wealth of Earth
3. To make understand students about the value of biodiversity through relevant case studies
4. To tell students about the richness of Uttarakhand state with respect to biodiversity
5. To make student sensible to check loss of biodiversity

COURSE OUTCOMES

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

1. Know about the biodiversity of the earth
2. Do the protective measures how to get benefitted from biodiversity
3. Get awareness among themselves to protect the biodiversity
4. Assessing and implementing case studies
5. Apply statistical and computational tools for protection of Biodiversity

SYLLABUS

UNIT-I **(8 Hours)**

Definition, historical and geographical causes for diversity, Biogeographic Zones of India, Types of Biodiversity, Himalayan Mountain System, Biodiversity with emphasis on Uttarakhand specifically Garhwal and Kumaon region

UNIT-II **(8 Hours)**

Germplasm, Germplasm Collection, Germplasm Regeneration, Importance of Germplasm in evolution. Germplasm Activities, Organization Associated with Germplasm in India and abroad, Gene pool, Gene Pool System of classification, Centres of Diversity & Gene Banks, Forest Fires and its consequences on biodiversity, Genetic Erosion.

UNIT-III **(8 Hours)**

Natural Resources, Components of biodiversity ,Plant Genetic Resources, Animal Genetics Resources, Fish Genetic Resources, their importance and significance and organizations involved in their respective conservation & research, species and population biodiversity, quantifying biodiversity. Field visits to biosphere reserves and national parks in Uttarakhand and outside.

UNIT-IV **(8 Hours)**

Maintenance of ecological biodiversity, Biodiversity and centres of origin, Centre of Diversity, Gene Banks, Biodiversity hot spots in India with emphasis to Uttarakhand, Loss of biodiversity, Biodiversity conservation of plant ,animal, fish, microbial genetic resources, Bioethics and conservation, The Biological Diversity Act, CBD and its milestones

UNIT-V **(8 Hours)**

Measuring, Assessing, analysing and documenting biodiversity statistical and computational tools, holistic concept of Bio-conservation, vulnerability and extinction of biodiversity, introduction to biodiversity database, Endangered animals, endemism and Red Data books, Case studies of biodiversity conservation in India , IUCN, Global Biodiversity Information System (GBIS), Data Bases of bio-diversity conservation

TEXT /REFERENCE BOOKS

1. Micheru, S.1885.Conservation of species and Genetic Resources. An NGO Action Guide.
2. Environment Liaison Center, Nairobi
3. SharmaP.D.2007.Ecologyand Environment. Rastogi Publications. Meerut BSI, 1996.Floraof India, Botanical Survey of India, Kolkata, India

BIODIVERSITY AND CONSERVATION (BTT-052)

L:T:P::3:0:0 **Credits-3**

4. Palni, L.M.S., Miakhuri R.K., RaoK.S.1998.Conservation of the Himalaya Agro-ecosystem: Issues and Priorities. UNDP, New York,USA
5. Anon.1996.TheWealthofIndia.VolI-XI.CSIR, New Delhi, India
6. Kandari,O.P. and Gusain, O.P. 2001. Garhwal Himalaya-Nature Culture and Society. Trans media Publication, Srinagar (Garhwal)
7. Mayers,N1990.ThebiodiversityChallenge:expanded'hot spots'analysis.-Envir10(4):243-256

BIOANALYTICAL TECHNOLOGY (BTT-053)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. A comprehensive knowledge of the equipment used in Biotechnology will be offered in the course along with the applications.
2. To acquire knowledge about bio-analytical techniques along with their theory, working principal, common instrumentation and possible applications.

COURSE OUTCOMES

On successful completion of this course students will be able to:

1. Define the fundamentals of various analytical methods for solving a given problem.
2. Handle and calculate instrumental measurements uncertainties.
3. Understand the requirements for successful operations of analytical techniques
4. Apply principles of various analytical devices used in research and enhance problem solving technique.

SYLLABUS

UNIT-I **(8 Hours)**

Introduction, Modern approaches in Bioanalysis and Bioassays, Types of analytical methods, Instrument for analysis, Uncertainties in Instrumental measurements sensitivity and detection limit, pH meter, sensors and their operation, Ion-selective, gas sensing electrodes and Oxygen electrodes,

UNIT-II **(8 Hours)**

Microscopic Techniques; Light Microscopy, Fluorescence microscopy, confocal microscopy, Atomic force microscope, Electron microscope, Scanning electron microscopy, Transmission Electron Microscope. Application of microscope in analysing biological samples.

UNIT-III **(8 Hours)**

Spectroscopic techniques: Beer-lamberts law and Apparent deviations, Instrumentation and applications - UV-Visible spectroscopy, Fluorescence spectroscopy, IR spectroscopy (FTIR & Raman) X-ray diffraction and crystallography, CD spectroscopy, and Mass spectroscopy, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermo gravimetric Analysis (TGA),

UNIT-IV **(8 Hours)**

Centrifugation; General principles, Ultra Centrifugation, Velocity sedimentation and Measurements, equilibrium,Ultracentrifugation -Density Gradient centrifugation. Electrophoresis; Principle, Design of horizontal and vertical gel electrophoresis apparatus, AGE, PAGE (SDS and Native), Isoelectric focusing**,** Pusle field gel electrophoresis (PFGE), 2-D gel electrophoresis, Capillary electrophoresis, application of electrophoresis in analyzing macromolecules, blotting techniques,

UNIT-V **(8 Hours)**

Chromatographic Techniques: Principles, Modes & Types of chromatography-Paper chromatography, Column chromatography – Gel permeation, Ion exchange, Affinity chromatography, reverse phase chromatography, GLC, HPLC, Gas Chromatography; PCR, its types and application in health and research, Immunological Techniques-ELISA, RIA, immunofluorescence and Flow cytometer.

TEXT /REFERENCE BOOKS:

1. Wilson, Keith, Andreas Hofmann, John M. Walker, and Samuel Clokie, eds. Wilson and Walker's principles and techniques of biochemistry and molecular biology. Cambridge University Press, 2018.
2. Jain, Aakanchha, Richa Jain, and Sourabh Jain. Basic techniques in biochemistry, microbiology and molecular biology. New York, NY, USA:: Springer, 2020.
3. Hobert, H. Willard, D. L. Merritt and J. R. J. A. Dean, Instrumental methods of analysis, CBS Publishers and Distributors, 1992.
4. F. Settle. Hand book of Instrumental Techniques for Analytical chemistry, Prentice Hall, 1997.

BIOMATERIALS AND TISSUE ENGINEERING (BTT-054)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. Strategies to modify and/or design materials that are biocompatible.
2. Explain what biocompatibility is and how it affects biomaterial design
3. Understand material selection and structure-function relationships
4. Identify methods to characterize biomedical implants and to assess the biocompatibility of biomaterials
5. Gain understanding of legal rights and moral duties of biomaterial engineer.

COURSE OUTCOMES

Upon completion of the course, the student will be able to

1. Gain fundamental knowledge of biomaterials and understand common use of biomaterials
2. Identify the right biomaterial on the basis of their chemical structure, properties and morphology
3. Learn about the properties of biological system and select biomaterial for the fabrication of scaffolds for tissue engineering
4. Illustrate the methods for the characterization and categorization of biomaterials, scaffolds and describe general methods for the assessment of biocompatibility of biomaterials.
5. Understand the interaction between biomaterial and tissue for short term and long-term implantations and identify solution to overcome the challenges in implantation and tissue engineering,

SYLLABUS

UNIT-I **(8 Hours)**

Introduction to Biomaterials: History of Biomaterials and Biomaterials Science, Biomaterials vs biological materials, Properties of Biomaterials, Water and its importance in Biomaterials

Examples of Biomaterial applications: In-vitro Applications, in-vivo applications, Biomedical applications: Cardiovascular, Dental implants, Orthopedic application, Skin, Ophthalmologic applications, and Biosensor applications.

UNIT-II **(8 Hours)**

Classes of materials used in biomedical implants: ***Bioactive Ceramics:*** Alumina, Hydroxyapatites: Porous Bioactive Glasses, ***Metallic Materials:*** Titanium Alloys, Stainless Steels, CoCr Alloys; ***Polymeric Biomaterials:*** Natural, Synthetic Polymers, Degradable and Resorbable Polymers, Hydrogels, Carbon Biomaterials.

UNIT-III **(8 Hours)**

Introduction to Tissue Engineering: Overview of Cell Culture and tissue culture; Primary Culture and Cell Lines; Properties of cultured cells; Extracellular Matrix and its properties; Natural and Synthetic Biomaterial Scaffolds, Scaffold Fabrication and transport in engineered tissue, Growth factors and their importance in tissue engineering;

Scaffold Applications: Cell delivery, Growth factor delivery; 3D Bio-printing. Transplantation, Replacing/Regenerating Target Organs, Drug Delivery, Disease Models

UNIT-IV **(8 Hours)**

Characterization of Biomaterials and Scaffolds: Need of biomaterial characterization, Principles and general methods of compositional and structural characterization techniques: X-ray, Mass spectrometery, electron microscopy, Tensile testing, Compressive testing, Rheology, EDAX, Thermal methods - DTA, TGA, DSC, DMA, temperature dependent rheology.

Assessment of biocompatibility of biomaterials: *in-vitro* biocompatibility assays (cellular adhesion, cellular viability using MTT, etc), *in-vivo* testing (Sensitization, Irritation, and Intracutaneous (Intradermal) Reactivity, Systemic Toxicity: Acute, Subacute, and Subchronic Toxicity), histo-compatibility assessment, Geno-toxicity assessment, Carcinogenicity.

BIOMATERIALS AND TISSUE ENGINEERING (BTT-054)

L:T:P::3:0:0 **Credits-3**

UNIT-V **(8 Hours)**

Material Response: Cell–Biomaterial Interactions, Blood-material interactions (BMI), Material and Tissue interaction, Biological environment and host response to implanted biomaterials- Inflammation, Wound Healing and Foreign Body Response.

Current Challenges and opportunities: Cell Source, Vascularization, Tissue Maturation; Failure mechanisms of biomedical implants: Corrosion, Fracture, Degradation of Implanted Materials – Polymers, Metals, Ceramics.

TEXT /REFERENCE BOOKS:

1. Wagner, William R., et al., eds. Biomaterials science: An introduction to materials in medicine. Academic Press, 2020.
2. B. D. Ratner, A. S. Hoffman, F. J. Schoen and J. E. Lemons, Biomaterials Science, Second Edition: Wiley Science (2004).
3. L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering (Woodhead Publishing in Materials (2002).
4. J. Breme, R. Thul and C. J. Kirkpatrick, Metallic Biomaterial Interfaces Wiley (2008).
5. Temenoff J.S. and Mikos A.G., Biomaterials: The intersection of Biology and Materials Science, Pearson, (2009).

DEPARTMENTAL ELECTIVE – II

FOOD BIOTECHNOLOGY (BTT-055)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To learn the principles involving food preservation.
2. To understand the principles that makes a food product safe for consumption.
3. To be aware about the principles and current practices of processing techniques and the effects of processing parameters on product quality.

COURSE OUTCOMES

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

1. Handle the basic food safety issues in the food market.
2. Develop and evaluate quality of new food products using objective and subjective methodologies.
3. Apply the basic concepts in food chemistry and food analysis.
4. Identify the conditions under which the important pathogens are commonly inactivated, killed or made harmless in food.

SYLLABUS

UNIT-I **(8 Hours)**

Scope and importance of food biotechnology, Role and significance of microorganisms in foods, Intrinsic and Extrinsic Parameters of Foods that affect microbial growth (pH, Moisture content, Water activity, Oxidation reduction Potential, Nutrient content, Biological Structure and Other inhibitory substance).

UNIT-II **(8 Hours)**

Contamination of Food, Sources of contamination, Microbiological standards of foods, General principle of Spoilage, types and causes of spoilage, Food poisoning and food borne infection by different microorganisms, Food toxins. Preservation of Food: Aseptic removal of Microorganism, Maintenance of Anaerobic condition,

UNIT-III **(8 Hours)**

Preservation of Food: Preservation by Using High temperature, Low temperature and Chemicals, Concept of Thermal Death Point, Z value, D- Value and F-value, Preservation by Radiation Processing of Foods for Irradiation, Application of Radiation, Radappertization, Radicidation, and Radurization of Foods Legal Status of Food Irradiation, Effect of Irradiation of Food constituents.

UNIT-IV **(8 Hours)**

Food fermentation: Bread, Beer, Cheese Production, SCP, medical foods, Concept of 'functional food'; GM food products , Mushroom cultivation, citric acid production, probiotics, Industrial Enzyme production: Amylases, proteinases, cellulaese.

UNIT-V **(8 Hours)**

Quality control of Food, Detection of food borne pathogen, Microbiological safety of food products, chemical safety of food products, Good Manufacturing Practice, AgMark, and BIS Standards, Food Safety and StandardAct (FSSA), Status of food processing industry in India and Abroad, Prospectus and constraints in development of Indian food industry.

Activity: industrial visit to companies related to Food Industry

TEXT /REFERENCE BOOKS:

2. Modern Food Micro-Biology by James M. Jay, (2000), 6th edition, An Aspen Pub., Maryland, USA.
3. Food Microbiology: Fundamentals and frontiers by M.P. Doyle, L.R. Beuchat and Thoma J. Montville, (2001), 2nd edition, ASM press, USA.
4. Food Science and Food Biotechnology by G.F.G. Lopez & G.V.B. Canovas (2003), CRCPress, Florida, USA.

HERBAL BIOTECHNOLOGY (BTT-056)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To acquire knowledge about medicinal plants and herbal medicine.
2. To understand the classification of plant-based drug.
3. To be familiar with the methods and techniques applied propagation of medicinal plants.

COURSE OUTCOMES

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

1. Identify medicinal plants of their state and country.
2. Understand techniques/methods used for cultivation of medicinal plants.
3. Do research on medicinal herbs and develop skills for a pharmaceutical industry

SYLLABUS

UNIT-I **(8 Hours)**

History, definition and scope of herbal medicine, the great contributors of medicine. Traditional and alternative system of medicine. Medicinal plants of Uttarakhand, scope of plant origin medicine in Uttarakhand. Classification of crude drugs of plant origin. Alphabetical classification, taxonomical classification, morphological classification, chemical classification, pharmacological (Therapeutic classification),Chemotaxonomic classification

UNIT-II **(8 Hours)**

Introduction to parts of medicinal plant cell organelles of plant cell, plant tissue, microscopy of plant, leaves, stems, flowers, fruits, seeds, bark, woods, underground drugs. Cultivation Methods Of propagation, methods of pest control, types of insertions used in cultivation and part harvest of herbal plants Plant growth regulators.

UNIT-III **(8 Hours)**

Cultivation and utilization of medicinal and aromatic plant in India. Genetic as applied to medicinal herbs research, genetic engineering and recombinant DNA technology. Plant tissue culture methods in propagation and improvement of medicinal plants. Case studies.

UNIT-IV **(8 Hours)**

Making and using herbal medicines for common ailments like cold, skin infections and Diarrhea; Analytical Profiles of selected herbs – Brahmi, Aradrographis paniculata Aegle wmarmelos and Gymnema sylvestre. Antimicrobial, anti-inflammatory and antibiotic drugs Screening procedures for herbal drugs with current innovations in following therapeutic classes Antihypertensive Antioxidant Antipyretic & anti-inflamatory Antidiabetic Anticancer Antihepatotoxic Immunomodulatory

UNIT-V **(8 Hours)**

QUALITY CONTROL OF HERBAL Quality Control and Quality Assurance of Herbal ingredients as per W.H.O.Guidelines, Determination of tannins, Ash value, Extractable matter and Pesticide residues. Herbal product development Lipid orals, tablets, capsules, dermatologic and herbal cosmetics Methods involved in monoherbal and polyherbal formulations with their merits and demerits

TEXT /REFERENCE BOOKS:

1- Dictionary of Indian Folk Medicine and Ethnobotany: A Reference Manual of Man-plant Relationships, Ethnic Groups & Ethnobotanists in India by S.H Jain. Deep publications New Delhi. 1991.
2- Plant Biotechnology by H.S. Chawla. Oxfords IBH publication. 2009.
3- Textbook of medical biochemistry by Challrzee M.N. and Shindi, R. Japee brother medicinal pub ltd. NewDelhi. 1995

AGRICULTURE BIOTECHNOLOGY (BTT-057)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES:

1. To gain deeper Knowledge of Agriculture through biotechnological tools
2. To address problems in all areas of agricultural production and processing
3. To develop low-cost disease, insect free planting materials for crops

COURSE OUTCOMES:

1. Student gains fair knowledge clearly by coming to a conclusion that biotechnology is more beneficial asper agriculture sector is concerned
2. Student will able to know the least controversial aspects of agricultural biotechnology are potentially themost powerful and the most beneficial for the poor.
3. Student will able to recognize agricultural biotechnology as understanding, characterizing and managinggenetic resources.

SYLLABUS

UNIT-I **(8 Hours)**

Introduction - Definition, classical vs modern approach, demand for biological resources, achievements, Nitrogen Fixation- Basic concepts, nif genes and their regulation, potential scope in crop improvement

UNIT-II **(8 Hours)**

Genetic engineering - aims of genetic engineering, techniques of gene manipulation, Transformation Techniques -Physical methods, agrobacterium, mediated transformation.

UNIT-III **(8 Hours)**

Transgenics - Basic concept and essential steps of the process, some examples of transgenic plants, use of suitable promoters, gene silencing and measures to overcome it, commercial aspects of the technology. Case studies involving transgenic crops.

UNIT-IV **(8 Hours)**

Molecular Markers - concept, SNPs, RAPD, RFLP, role in crop improvement and genome mapping, Molecular and biochemical basis, signalling pathways in the production of transgenic plants for fungal, bacterial and viral disease resistance; herbicide resistance, pest resistance, drought and other abiotic stress resistance

UNIT-V **(8 Hours)**

Plant as Biofactories - Concept, production of chemicals, pigments, perfume, flavours, insecticides, anticancer agents and other important compounds, molecular farming, use of plants for production of nutraceuticals, edible vaccines and other desired products, SCP - micro-organisms, nutritional value, production of algal biornass, bio fertilizers and bio pesticides, mass cultivation of Rhizobium, Azotobacter, Azospirillum, Mycorrhiza, blue-green algae and Azolla.

TEXT/ REFERENCE BOOK:

1. Agricultural Biotechnology" by Arie Altman, Marcel Dekker, Inc. (2001) "Agricultural Biotechnology", by S.S.Purohit, Agro Bios (India)
2. Molecular Biotechnology Principles and Applications of Recombinant DNA, by Bernard R. Glick andJack J. Pasternak,. ASM Press

ANIMAL BIOTECHNOLOGY (BTT-058)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES:

1. To learn the basic of animal tissue culture and the composition of different types of medium and the role of serum used in cell culture.
2. To gain knowledge about different types of cell culture methods and applications of cell culture.
3. To impart knowledge on production of transgenic animals, maintenance of cell lines and in vitro application of cell and molecular techniques.
4. To understand the principles of animal cloning and its applications.

COURSE OUTCOMES

1. Acquire knowledge for isolation, maintenance and growth of cells.
2. Develop proficiency in establishing and maintaining of cell lines.
3. Acquire knowledge in micromanipulation technology and transgenic animal technology.
4. Use the knowledge gained to apply in the field of clinical research.

SYLLABUS

UNIT-I **(8 Hours)**

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, Design, Layout and Equipment: Planning, Construction, Layout, Essential Equipment's, Aseptic Technique, Objectives, Elements, Sterile Handling, Safety, Risk Assessment, General Safety, Application, CultureEnvironment, Cell Adhesion, Cell Proliferation, Differentiation,

UNIT-II **(8 Hours)**

Media used for Animal Cellculture: Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Serum-Free Media, Disadvantages of Serum, Advantages of Serum-Free media, Scale up of Cell Culture: Principles and Procedure, Factors affecting scale up; Growth monitoring during scale up.

UNIT-III **(8 Hours)**

Primary Culture: Isolation of Tissue, Steps involved in primary cell culture, Subculture and Propagation, Cell Lines: Development, Nomenclature, Cell line designations, Routine maintenance, Immortalization of cell lines, Need for characterization and maintenance of cell lines, Cell Morphology, Transformation, Source of contamination, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross- Contamination

UNIT-IV **(8 Hours)**

Cryopreservation: Need of Cryopreservation, Preservation, Cell banks, Transporting Cells, Cytotoxicity its in vitro limitations, Nature of assay, Viability assay, Survival assay, Microtitration assay, Transformation assay, Methods of Producing Transgenic Animals: Embryonic Stem Cell method, Microinjection method, Retroviral vector method, Applications of transgenic animals, Knock-out, Knock-in, Conditional Knock out mouse, Mouse as a Model, Animal as Bioreactors.

UNIT-V **(8 Hours)**

Gene Therapy: Animal diseases, diagnosis, therapy, control and management of disease spreading, Ex-vivo gene therapy, In vivo gene therapy, Viral gene delivery system, Retrovirus vector system, Adenovirus vector system, Adeno-Associated virus vector system, Herpes simplex virus vector system, Non-viral gene delivery system, Prodrug activation therapy, Nucleic acid therapeutic agents, Gene Therapy for human genetic disorders.

ANIMAL BIOTECHNOLOGY (BTT-058)

L:T:P::3:0:0 **Credits-3**

TEXT /REFERENCE BOOKS:

1. Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications, (6th Ed), by R. IanFreshney, John Wiley & Sons, 2010.
2. Animal Cell Biotechnology: Methods and Protocols, (2nd Ed),by Ralf Portner, Humana Press, 2007.
3. Animal Cell Culture (A Practical Approach) (3rd Ed) by John R.W. Masters, Oxford University Press, 2000.

BIOINFORMATICS LAB (BTP-008)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions of Biological Databases, Biological data retrieval tools, Genetic algorithm, alignments between sequence and molecular visualization tools etc in laboratory.

COURSE OUTCOMES

1. To formulate, analyze and solve a multilevel laboratory problems in Bioinformatics lab.
2. To demonstrate experimental comprehension of Homology modeling for protein structure, Protein and nucleotide sequence databases.
3. To analyze the Alignment search tools, Matrixes and biomolecule visualization tools for biological data.
4. To handle various experiments in the area of Bioinformatics, Computation and system biology
5. To think innovatively and improve the data inoperative skills those are essential for engineers.

LIST OF EXPERIMENTS

1. To learn to use biological databases with reference to Expaxy and NCBI.
2. To retrieve the sequence of the Human keratin protein from Gen Bank database and to

1. Interpret the results.
2. To compare the local and global alignments between the given sequences
3. To determine the Post Translational Modifications involved in P53355 and to
4. Determine the residues involved in PTM.
5. To determine the conserved domain present in Q8NFM4
6. To perform the local alignment between the given sequences using any two variants
7. of BLOSUM
8. To align more than two sequences and find out the similarity between those sequences
9. To find the similarity between sequences using BLAST
10. To predict secondary structure of the give protein sequences
11. To determine the tertiary structure of P68871 AND P24071

TEXT /REFERENCE BOOKS

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (Methods of Biochemical Analysis), (2^{nd} edition) by Andreas D Boxevanis, Wiley–Blackwell, (2001).
2. Bioinformatics: Volume I: Data, Sequence Analysis, and Evolution (Methods in Molecular Biology), (3^{rd}edition) by Jonathan M. Keith,Humana press, (2017)

ENZYME TECHNOLOGY LAB (BTP-009)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions of various types of l enzyme's kinetic properties, enzymatic extraction method, enzyme activity, enzyme immobilization and its assay methods etc with the help of related instruments and devices.

COURSE OUTCOMES

1. To formulate, analyze and solve a multilevel laboratory problems in enzyme technology lab.
2. To demonstrate experimental observation of enzymatic kinetic properties and enzyme activity.
3. To analyze the concept of extraction, purification methods for enzymes and determination of enzymatic reaction in lab.
4. To handle various experiments in the enzymology, enzyme kinetics and immobilization methods.
5. To think creative and improve data interpretation skills those are essential for engineers

LIST OF EXPERIMENTS

1. To prepare a sample of enzyme extract.
2. To obtain standard curve of p-nitrophenol solution.
3. Determination of enzyme activity and specific activity.
4. Determination of kinetic properties (Km and Vmax values) of an enzyme.
5. Determination of optimum pH for enzyme
6. Determination of optimum temperature for an enzyme
7. To determine activity of acid phosphatase from peas/moong seedlings.
8. Purification of an enzymatic protein by salt precipitation.
9. To check time and protein linearity of an enzymatic reaction.
10. To find activity of salivary amylase at different concentration.
11. Molecular weight determination of enzyme by Gel filtration method
12. Method of checking the purity of the enzyme -SDS-PAGE
13. Immobilization of an enzyme and study of immobilized enzyme kinetics.

TEXT /REFERENCE BOOKS

1. Laboratory Manual for Biotechnology by Verma, Ashish S./ Das Surajit & Singh Anchal, S. Chand publication, 2014.
2. Comprehensive Laboratory Manual Of Life Sciences By- J. Saxena, Mamta Baunthiyal,I.Ravi, Scientific Publication, 2019

CELL & TISSUE CULTURE LAB (BTP-010)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions of practical knowledge, required for dealing with animal cell and tissue cultures in vitro and to prepare students capable to maintain plant cells, tissues and its culture methods under in vitro conditions.tc with the help of related instruments and devices.

COURSE OUTCOMES

1. To formulate, analyze and solve a multilevel laboratory problems in Cell and tissue culture lab.
2. To demonstrate experimental observation of callus, suspension and seed culture of explant.
3. To analyze the concept of sterilization, asceptic conditions for plant tissue culture and micropropagation methods through meristem culture in lab.
4. To handle various experiments in the Agricultural field, Plant and animal tissue culture.
5. To think creative and scientific and motivational skills those are essential for engineers

LIST OF EXPERIMENTS

1. Study and use of basic sterilization techniques in tissue culture lab.
2. Preparation of tissue culture media.
3. Selection and preparation of explant for tissue culture.
4. Cell culture in static phase (T-flask)
5. Culture and maintenance of monolayer culture, quantification of cell growth
6. Determination of critical shear stress, micro carrier and perfusion culture
7. To perform seed culture experiment.
8. To perform micropropagation through meristem culture.
9. To perform suspension culture and callus culture from medicinal plants.
10. Artificial seeds preparation
11. To perform Shoot tip culture
12. Hardening and Planting in field
13. Cell suspension culture
14. Economics of micropropagation project

INTERNSHIP-II/MINI PROJECT-II (BTP-011)

L:T:P::0:0:2 **Credits-1**

CONSTITUTION OF INDIA (AHT-009)

L:T:P:: 2:0:0 **Credits-0**

COURSE OBJECTIVE:

1. To acquaint the students with legacies of constitutional development in India and help to understand the most diversified legal document of India and philosophy behind it.
2. To make students aware of the theoretical and functional aspects of the Indian Parliamentary System.
3. To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers.

COURSE OUTCOMES

The course should enable the students to:

1. Understand the basic knowledge and salient features of Indian Constitution.
2. Identify and explore the basic features and modalities about Indian constitution.
3. Discusses the essence of Union and its territories, Citizenship, Fundamental Rights, DPSP and Fundamental Duties.
4. Differentiate and relate the functioning of Indian parliamentary system at the center and state level.
5. Differentiate different aspects of Indian Legal System and its related bodies.

Unit-1 Constitutional Framework

Meaning of Terms and Phrases frequently used in political system like constitution, constitutionalism, Rule of Law, Federal system, Government and so on. Historical Background of Indian Constitution, Making of Indian Constitution, Salient features of Indian Constitution, Preamble of Indian Constitution.

Unit-2 Different Parts, Articles, and their significance

Part I to IVA (Union and its territories w.r.t. Indian States, Citizenship, Fundamental Rights conferred to citizens and foreigners, Directive Principles of State Policy– Its importance and implementation and Fundamental Duties and its legal status), Article 1 to 51A and their significance.

Unit-3 System of Government

Parliamentary Form of Government in India – The constitution powers and status of the President of India, Federal structure and distribution of legislative and financial powers between the Union and the States, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Amendment of the Constitutional Powers and Procedure and the significance of basic structure in Indian Judicial system

Unit-4 Working of Central, State & Local Self Government as per constitution

Framework for central government (President, Vice president, Prime Minister, Central council of ministers, Parliament, Supreme court and so on), Framework for state government (Governor, Chief Minister, state legislature, High court and so on) and Framework for local self government (Panchayatiraj, Municipalities) and Union Territories.

Unit-5 Constitutional, Non-Constitutional and other bodies

Discussion on Various constitutional bodies like Election Commission, UPSC, SPSC, Finance commission, NCSC, NCST, NCBC, CAG and AGI. Discussion on Various non-constitutional bodies like NITI Aayog, NHRC, CIC, CVC, CBI, Lokpal and Lokayukta. Discussion on Various other constitutional bodies like Co- operative societies, Official Language, Tribunals etc.

Text/Reference books-

1. M. Laxmikanth, “Indian Polity”, McGraw- Hill, 6th edition, 2020
2. D.D. Basu, “Introduction to the Indian Constitution”, LexisNexis, 21st edition, 2020
3. S.C. Kashyap, “ Constitution of India”, Vitasta publishing Pvt. Ltd., 2019

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (AHT-010)

L:T:P:: 2:0:0 **Credits-0**

COURSE OBJECTIVES:

The course should enable the students to:

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyse it and apply it to their day to day life.
3. To make the students know the need and importance of protecting traditional knowledge.
4. To make the students understand the concepts of Intellectual property to protect the traditional knowledge.
5. This course is also concentrating on various acts in protecting the environment and Knowledge management impact on various sectors in the economy development of the country.

COURSE OUTCOMES:

The course should enable the students to:

1. Understand the concept of Traditional knowledge and its importance.
2. Know the need and importance of protecting traditional knowledge.
3. Know the various enactments related to the protection of traditional knowledge.
4. Understand the concepts of Intellectual property to protect the traditional knowledge.
5. Know the contribution of scientists of different areas.

Unit – 1 Introduction to Traditional and Culture Knowledge

Define culture, traditional, civilization and heritage knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK). Indigenous traditional knowledge Vs western traditional knowledge vis-à-vis formal knowledge.

Unit-2 Protection of Traditional Knowledge

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of traditional knowledge Protection, value of traditional knowledge in global economy, Role of Government to harness traditional knowledge.

Unit – 3 Traditional Knowledge and Intellectual Property

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Global legal forums for increasing protection of Indian Traditional Knowledge.

Unit – 4 Traditional Knowledge in Different Sectors

Traditional knowledge in engineering, biotechnology and agriculture, traditional medicine system, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of traditional knowledge.

Unit – 5 Education System in India

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

Text/Reference Books:

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
3. Traditional Knowledge System in India, by Amit Jha, 2009.
4. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
5. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.

DOWN STREAM PROCESSING (BTT-013)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To introduce the various techniques of product isolation and purification from fermentation broth likeremovable of insoluble, primary isolation, purification and final polishing.
2. To analyze and solve problems related to separation technique.

COURSE OUTCOMES

After completion of the course

1. The student will develop skills to carry on lab experiments related to the subjects.
2. Students will have ability to analyze and select the appropriate technique for product recovery and purification.
3. Students will develop theoretical knowledge which they can apply in bioprocess and otherindustries.
4. Students will be able to demonstrate critical thinking, problem solving and decision-makingAbilities.
5. Describe the components of downstream equipment and explain the purpose of each

SYLLABUS

UNIT-I **(8 Hours)**

Introduction: History and scope of downstream processing in biotechnology, problems, requirement of purification, Characteristics of biotechnology products and fermentation broth, classes of bioproducts, physicochemical basis of bio separation. Process economics: Capital and operating cost analysis, generic scheme of bioseparation.

UNIT-II **(8 Hours)**

Cell disruption methods for intracellular products, solid liquid separation: Separation of particulate by filtration, centrifugation, settling, sedimentation, decanting and micro filtration, foam based separation. Methods for Pre-treatment of fermentation broth.

UNIT-III **(8 Hours)**

Primary isolation methods : Adsorption Principles, Langumir - Freundlich isotherms, Extraction: basics- Batch and continuous, aqueous two-phase extraction, supercritical fluid extraction - *in situ p*roduct removal, Precipitation: Methods of precipitation with salts - organic solvents and polymers, Membrane based separations processes- Microfiltration, ultrafiltration, reverse osmosis, nano filtration, electrodialysis - theory -design and configuration of membrane separation equipment and its applications.

UNIT-IV **(8 Hours)**

Basic principles of Chromatographic separations: GC-HPLC - gel permeation - ion-exchange -affinity - reverse phase and hydrophobic interaction chromatography – Electrophoretic separation techniques: capillary electrophoresis, isoelectric focusing-2D gel electrophoresis - Hybrid separation technologies: GC-MS and LC-MS.

UNIT-V **(8 Hours)**

Final product formulation and finishing operation: theory and equipment- crystallization, drying and lyophilization, Product recovery of ethanol, citric acid, penicillin, recombinant renin from *E.coli*. Typical examples for downstream Processing and effluent disposal in process industries

TEXT /REFERENCE BOOKS:

1. Bioseparation: Downstream Processing for Biotechnology, by Belter, P. A.; Cussler E. L. and Hu W. S.(2003) John Wiley & Sons. OXFORD.
2. Bioseparation : Principles and Techniques by Shivashankar, PHI, 2005.
3. Bioprocess Engineering Principles, 2nd Edition by Pauline M Doran Academic Press, USA.(2013)
4. Bioseparation science and engineering by Harrison et al. Oxford Univ. Press (2006)

ENVIRONMENT BIOTECHNOLOGY (BTT-014)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To understand the concepts of ecosystem and environmental pollution.
2. To understand the use of conventional and emerging biotechnological process for treatment of waste water and solid waste management.
3. To discuss the role of environmental biotechnology in bioremediation, agriculture and energy sector.

COURSE OUTCOMES

At the end of the course, the students will

1. Learn the sources and effects of different types of environmental pollution, concept of ecosystem, environmental laws and policies.
2. Be able to apply molecular and biotechnological techniques for environment monitoring.
3. Be able to apply environmental biotechnology for waste water treatment, bioremediation, sustainableagriculture and production of biofuels.
4. Be able to create awareness among society towards environmental pollution and its ill effect.

SYLLABUS

UNIT-I **(8 Hours)**

Introduction to Environment: Concept of ecology and ecosystem, environmental pollution (Water, soil and air), noise and thermal pollution: their sources and effects. Microplastic waste. Nuclear and Radiation Pollution, Types of Radiation and their genetic Consequences, Environmental laws and policies.

UNIT-II **(8 Hours)**

Microbiology and biochemistry of waste water treatment, Biological Treatment of anaerobic and aerobic; methanogenesis, methanogenic, acetogenic, and fermentative bacteria- technical process and conditions; Use of Genetically Engineered Organisms. emerging biotechnological processes in waste - water treatment; Applications include treatment of municipal and industrial wastewaters.

UNIT-III **(8 Hours)**

Solid waste management: Landfills, composting, earthworm treatment, recycling and processing of organic residues. Biodegradation of xenobiotic compounds, Organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants. Microbial treatment of oil pollution. Case studies

UNIT-IV **(8 Hours)**

Bioremediation and Biorestoration: Reforestation through Micropropagation, Development of stress tolerant plants, Use of mycorrhizae in reforestation, Use of microbes for improving soil fertility, Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal Accumulation, Biosorption & detoxification mechanisms

Reforestation of soils contaminated with heavy metals. Case studies

UNIT-V **(8 Hours)**

Environmental Biotechnology in Agriculture: Biofertilizers and microbial inoculants, biopesticide, bioinsecticides, bioherbicides. Biofuel: Plant derived fuels, Energy crops, Biogas, Bioethanol, biohydrogen Environmental genetics: degradative plasmids, release of genetically engineered microbesin environment.

TEXT / REFERENCE BOOKS:

1. An Introduction to Environmental Biotechnology by M. Wainwright. Kluwer Academic Press (1999)
2. Environmental Biotechnology by Alan Scragg. Longman (1999)
3. Environmental Biotechnology: A Biosystems Approach (second Edition) by Daniel Vallero. Academic Press, (2015)

PLANT BIOTECHNOLOGY (BTT-015)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To introduce biotechnology methods in plants.
2. To give students new knowledge and widening of the knowledge acquired in other course by handling of classical and modern plant biotechnology processes, including breeding of healthy plants, plants with improved characteristics and plants for biomolecules production.
3. To make understand student aware of biotechnological processes those also applicative value in pharmaceutical and food industry, in agriculture and in ecology.

COURSE OUTCOMES

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

1. Concepts, principles and processes in plant biotechnology.
2. Applications. Presentation of ongoing research.
3. Reflexion. The ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological, pharmaceutical, medical and agricultural applications.
4. Transmissible skills. Critic usage of literature and other sources, collection and interpretation of data, scientific and technical terminology.

SYLLABUS

UNIT-I **(8 Hours)**

Introduction Definition, History of tissue culture techniques, Classical versus modern approach, Laboratory requirement for plant Tissue Culture, Sterilization, Culture media(MS,B5 and White's media) and theircomponents, Cell Culture, Cell viability test, Cell and Organ Differentiation,

UNIT-II **(8 Hours)**

Clonal Propagation ormicropropagation, artificial Seeds, Production of disease free plants explants, shoot tip culture, shoot tip grafting, Production of haploids, anther culture, ovule culture, use of haploids in plant Breeding, maintenance of virus free stocks, applications and limitations, pollen culture, ovary culture,

UNIT-III **(8 Hours)**

Embryo culture, Embryo rescue, Protoplast Related Techniques Protoplast, Isolation, Culture and fusion, Selection of hybrid cells, regeneration of hybrid plants, somatic hybridization and cybridization, Applications in crop improvement, Plant as Biofactories Concept, Production of Chemicals, Pigments, Perfume, Flavours, Insecticides, anticancer agents and other important compounds.

UNIT-IV **(8 Hours)**

Germplasm conservation, Cryopreservation, Transformation Techniques Physical methods, *Agrobacterium*, Mediated transformation Transgenics basic concept and essential steps of the process, some examples of transgenic plants, use of suitable promoters, Gene silencing and measures to overcome it, Commercial aspects of the technology.

UNIT-V **(8 Hours)**

Molecular Markers Concept, SNPs, RAPD, RFLP, ISSR, STMS, role in crop improvement and genome mapping. Production of Transgenic plants, vectors for production of transgenic plants, Integration and Inheritance of Transgenes, Applications of transgenic technology.

TEXT/REFERENCES BOOKS

1. Plant Tissue Culture: Applications and Limitations. S.S. Bhojwani (1990), Elsevier, Amsterdam.
2. Micropropagation: P.C. Debergh and R.H. Zimmerman (1990), Kluwer Academic Publ. Dordrecht.
3. Elements of Biotechnology: P. K. Gupta. Rastogi Publications
4. Plants Biotechnology: H. S. Chawala (2014). Oxford & IBH Publications

DEPARTMENTAL ELECTIVE: 3

GENOMICS AND PROTEOMICS (BTT-059)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To learn the basics of Genomics and Proteomics.
2. To understand the principles of practical applications of Genomics and Proteomics.
3. To know about applications of bioinformatics to solve genomics and Proteomics problems.

COURSE OUTCOMES:

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

1. Aware about techniques of genomics and proteomics.
2. Develop new systems and technologies by using genomics and proteomics tools for solving complex genetically critical problems.
3. Characterize and sequence important plant and animal genomes for potential human applications for betterment of human society

SYLLABUS

UNIT-I **(8 Hours)**

Introduction to Genomics: Gene, Genome and Genomics, Types of Genomics: Structural, Functional and comparative Genomics, Human Genome Project: Timeline of Events, Goals, Salient features, Applications and future challenges, Sequences Comparison Techniques: BLAST.

UNIT-II **(8 Hours)**

DNA sequencing – Introduction, General Process of DNA Sequencing, Chemical and enzymatic methods, Next generation Sequencing, Genome assembly, Genome Validation, Genome Annotation, commonly used genome annotation tools and programs, Overview of Gene prediction software, Comparative Genomic analysis.

UNIT-III **(8 Hours)**

DNA Fingerprinting: Principle of DNA Fingerprinting, Satellites DNA, Steps involved in DNA Fingerprinting, Applications of DNA fingerprinting, Case study in DNA Fingerprinting. **Phylogenetic analysis:** Phylogenetic tree & its types, Construction of Phylogenetic tree using MEGA (Molecular Evolutionary Genetic Analysis).

UNIT-IV **(8 Hours)**

Introduction to proteomics: Basics of Proteins and Proteomics, General strategy for proteome projects**,** how to analyze a Proteome – 2D-gel electrophoresis, high-throughput proteome analysis with 2D-IEF, MALDI-TOF mass spectrometry.

UNIT-V **(8 Hours)**

Pharmacogenomics, Clinical applications of Genomic technologies, Proteome analysis, Proteomics resources at the EBI: UniProtKB, IntAct, Reactome and PRIDE, Software & tools for proteome data exploration available via the Internet, Proteomics: Technologies and their applications, Proteomics in the pharmaceutical industry

TEXT /REFERENCE BOOKS:

2. Genomes II, T.A. Brown (2014)
3. Biotechnology and Genomics by P. K. Gupta (2011)
4. A Primer of Genome Science, Greg Gibson and Spencer V. Muse
5. Biology: Principles and Practice, Arthur M.
6. Gene Cloning and DNA Analysis – An introduction (Fourth Edition), T.A. Brown
7. Genes & Genomes, Maxine Singer and Paul Berg
8. Essential of Genomics and Bioinformatics, C.W. Sensen, John Wiley and Sons Inc.

IPR, BIOETHICS & BIOSAFETY (BTT-060)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To create awareness on IPR issues and need for knowledge in patents in biotechnology
2. To understand the biosafety regulations and ethical practices in biotechnology
3. To become familiarize with the ethical practices in biotechnology

COURSE COUTCOMES:

Students will be able:

1. To understand and follow the regulatory framework important for the product safety and benefit for the society.
2. To devise business strategies by taking account of IPRs
3. To acquire adequate knowledge in the use of genetically modified organisms and its effect on human health
4. To gain more insights into the regulatory affairs

SYLLABUS

UNIT-I **(8 Hours)**

IPR definition and types, history &legislations covering IPRs in India,TRIPS**,**Patents**:** Introduction to patent law and conditions for patentability; Procedure for obtaining patents; Rights of a patentee; Patent infringements; grounds for opposition of patent, Non Patentable inventions in India, Exclusive Marketing Right(EMR),Paris Convention, Patent Cooperation Treaty(PCT),Budapest Treaty, WIPO, Biotechnology patents and patents on computer programs

UNIT-II **(8 Hours)**

Copyright: Registration procedure and copyright authorities; requirements for filing the copyright application in India, Industries that comprise the business of Copyright, Assignment and transfer of copyright , Copyright infringement and exceptions to infringement ;Problems faced by copyright holders with the advent of new technologies in the digital world, licensing in terms of computer software, International Conventions and Treaties associated with copy right adopted by India, Introduction to the law on Industrial Designs; Copyright in design, Registration and piracy; International perspective; essential requirements for the registration of design under the Designs Act,2000.

UNIT-III **(8 Hours)**

Origin of Trade Mark, Trade Mark offices in India, Different types of Trade Mark, Elements of Trade Marks, Register of Trade Mark, Madrid Agreement, Madrid Protocol, Important Treaties and Policies of Trade Marks,Criteria of Trade Secret, Reverse engineering, Georaphical Indications(GIs),Importance of GIs in India, Ways to protect GIs,Benefits of GIs,Plant breeders' and farmers' rights; PPVFR Act ,2001,cost of registering aplant variety, Biodiversity Appropriate case studies.

UNIT-IV **(8 Hours)**

Bioethics and Legal Issues: Ethical issues; Public perception related to Biotechnology from developed and developing countries, Legal and socio-economic impacts of biotechnology, public awareness on genetically modified life forms (case study), Ethical implication of biotechnological products and technique, Bio-terrorism, Social and ethical implication of biological weapons. Human Genome project and its ethical issues. Xeno transplantation and its social and ethical consequences.

UNIT-V **(8 Hours)**

Biosafety and Risk Assessment: Introduction; Historical Background; Definitions, Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety levels; specific microorganisms; Recommended biosafety levels for Infectious agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant

IPR, BIOETHICS & BIOSAFETY (BTT-060)

L:T:P::3:0:0 **Credits-3**

International Agreements including Cartagena Protocol, GMP and GLP. Guidelines for transgenic plant, animals and microbes

Reference Books:

1. Deepa Goel &Shomini Parashar IPR, Biosafety and Bioethics, Pearson Education India, (2013)
2. Anupam Singh Intellectual Property Rights and Bio-Technology Biosafety and Bioethics, Narendra Publishing House, (2012)
3. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., (2007)
4. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd.,(2007)
5. Patent Strategy for Researches & Research Managers- Knight, Wiley Publications
6. Agriculture & Intellectual & Property Rights, V. Santaniello & R E Evenson, University Press.
7. Biotechnology & Safety Assessment, Thomas, Ane/Rout Publishers.
8. Biotechnology Expanding Horizons, Kalyani Publishers.

MASS TRANSFER (BTT-061)

L:T:P::3:0:0 **Credits-3**

COUSE OBJECTIVES

1. To understand the basic concepts of mass transfer phenomena; diffusion, interphase mass transfer, mass transfer coefficients.
2. To impart knowledge of Equipments for gas-liquid mass transfer operations.
3. To understand absorption and distillation operations and the process design aspects ofthese operations.

COURSE OUTCOMES

After completion of the course, students will be able to

1. Understand and define the basic principles of diffusion, convective mass transfer, interphase mass transferand mass transfer coefficients.
2. Apply knowledge of mass transfer phenomena in the design of process equipment in absorption and distillation operations.
3. Develop skills in the area of Mass Transfer operations. This will be beneficial to students for the study ofspecialized electives and project work.

SYLLABUS

UNIT-I **(8 Hours)**

Molecular diffusion in fluids: Binary solutions, Fick's law, Diffusion coefficient, Equation of continuity, Steady state equimolar counter diffusion, Maxwell–Stefan diffusion, Estimation of diffusivity of gases and liquids, Application of the principles of molecular diffusion.

UNIT-II **(8 Hours)**

Mass transfer: Mass transfer coefficients, Theories of mass transfer, Analogy between momentum, heat and mass transfer. Dimensionless groups and Correlations for convective mass transfer coefficients. Diffusion in solids. Interphase mass transfer: Concept of equilibrium, The Raoult's law and the Henry's law, two resistancetheory. Material balances in steady state co-current and counter-current stage processes.

UNIT-III **(8 Hours)**

Equipment for gas-liquid operations; Gas dispersed and Liquid dispersed equipment: Sparged vessels, mechanically agitated vessels for single phase liquids and gas-liquid mixtures, Tray towers, Sieve tray for absorption and distillation, Venturi scrubbers, Spray towers and spray chambers, Packed towers for absorptionand distillation, Tray towers versus packed towers.

UNIT-IV **(8 Hours)**

Absorption: Solubility of gases in liquids, Ideal and non-ideal solution, Choice of solvent for absorption, Single component absorption material balance, Liquid gas ratio for absorption, Counter current multi stage operation, Number of trays and tray efficiency, Absorption factor, Continuous contact equipments, HETP andHTU and NTU concepts for single operation. Absorption with chemical reaction

UNIT-V **(8 Hours)**

Distillation: Principles of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation, steam distillation, continuous distillation, Analysis of binary distillation: McCabe-Thiele Method, Ponchon- Savarit method. Introduction to multi-component distillation, azeotropic and extractive distillations.

TEXT /REFERENCE BOOKS

1. Mass transfer Operations (3rd edition) by Robert E. Treybal. McGraw-Hill Book Co, (1980)
2. Principles of Mass transfer and Separation Processes by B. K. Dutta. PHI, New Delhi, (2009).
3. Unit Operations in Chemical Engineering (5th Edition) by McCabe W.L., Smith J.C., Harriott P. McGraw-Hill Book Co, (1993)

MEDICAL DIAGNOSTIC TECHNIQUES (BTT-062)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVE

The students will be exposed to

1. Electrical and non-electrical physiological measurements
2. Learn about biomedical Recorders.
3. Understand the measurement of non-electrical parameters.
4. Learn biochemical measurement.
5. Understand the patient safety and electro medical equipments

COURSE OUTCOMES

At the end of the course, the student should be able to:

1. Learn the concept of man instrumentation system
2. Explain the function of Biomedical Recorders
3. Perform electrical and non-electrical physiological measurements.
4. Analyse the working of biochemical measurement
5. Learn the about the patient care and monitoring.

SYLLABUS

UNIT -1 **(8 Hours)**

Introduction to Biomedical Instrumentation: Components of the man- instrument system, Specifications of medical instrumentation systems, Problem encountered in measuring living system, Basic transducers principles, Active and passive transducers, transducer for biomedical applications.

UNIT-II **(8 Hours)**

Biomedical Recorders: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes – Electrode-tissue interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes, Needle electrodes.

UNIT-III **(8 Hours)**

Measurement of non-electrical parameters: Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

UNIT-IV **(8 Hours)**

Bio-chemical measurement: Biochemical sensors - pH, pO2 and pCO2, Ion select Field-effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

UNIT-V **(8 Hours)**

Patient safety and electromedical equipment: physiological effects of electrical currents, macroshock and microshock, preventive measures to reduce shock hazards, Leakage current, isolation of patient circuits, safety of electrically susceptible patients, radiation hazards and safety, shielding, open ground problem and earthing methods.

TEXT /REFERENCE BOOKS:

1. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, 2004.
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, 2003.
3. Leslie Cromwell, “Biomedical Instrumentation and measurement”, Prentice hall of India, New Delhi, 2007.

MEDICAL DIAGNOSTIC TECHNIQUES (BTT-062)

L:T:P::3:0:0 **Credits-3**

4. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2003.
5. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
6. R.Anandanatarajan, "Biomedical Instrumentation", PHI Learning, 2009

DOWN STREAM PROCESSING LAB (BTP-012)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions of various types of downstream processing steps, unit operations for solid-liquid operation, isolation, concentration and purification of various types of products after fermentation in bioprocess laboratory.

COURSE OUTCOMES

At the end of the course, the student should be able to:

1. Formulate, analyze and solve a multilevel laboratory problems in downstream processing lab.
2. Demonstrate experimental observation of analytical techniques and high resolution chromatographic techniques in lab.
3. Analyze the concept of Centrifugation, Filtration and enzymatic, physical cell disruption methods in lab.
4. Handle various experiments in the downstream process, bioanalytical and bioprocess engineering lab.
5. Think creative and improve logical, data interpretation skills those are essential for engineers

LIST OF EXPERIMENTS

1. Introduction to downstream processing
2. Tangential Flow Filtration System
3. Centrifugation studies during the settling of yeast cells
4. Yeast cells disruption by mechanical method
5. Design of thickener for batch sedimentation using Kynch's theory
6. Estimation of Organic acid by calorimetric method
7. Determination of partition coefficient and yield of yeast cells using aqueous two-phase extraction
8. Extraction of pigments from spinach and estimation by thin layer chromatography
9. Ammonium sulfate precipitation of proteins using yeast cell suspension
10. Determination of drying time for a given sample in a vacuum tray drier
11. Gas Chromatography analysis for a compound
12. Crystallization of a product
13. Ethanol fermentation experiment
14. To perform soxhlet extraction in a given sample
15. Dialysis for desalting the micromolecules

LAB MANUAL/REFRENCE BOOK

1. Laboratory Manual for Biotechnology by Verma, Ashish S./ Das Surajit& Singh Anchal, S. Chand publication, 2014.
2. Biosperation lab manual by Hazem Al Khaldy, Baraa Abu Asaker ,Amera El Sersawi
3. P.A. Belter, E.L. CusslerAnd Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun. (1988).
4. R.O. Jenkins, (Ed.) – Product Recovery in Bioprocess Technology – Biotechnology ByOpen Learning Series, Butterworth-Heinemann (1992).
5. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High ResolutionMethods And Applications, VCH Pub. 1989.

ENVIORNMENT BIOTECH LAB (BTP-013)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions of various types of Physical, chemical and biological properties for water sample, xenobiotic degradation by microbe, processing and monitoring of water pollution etc. with the help of instrument and devices in lab.

COURSE OUTCOMES

At the end of the course, the student should be able to:

1. Formulate, analyze and solve a multilevel laboratory problems in Environment biotech lab.
2. Demonstrate experimental observation of BOD, COD and microscopic characterization for water sample in lab.
3. Analyze the concept of Hardness, Total solid, Total suspended solid and Volatile Suspended Solids in waste water sample in lab.
4. Handle various experiments in the Environment biotech, Microbiology and waste processing.
5. Think creative and improve logical, innovative skills those are essential for engineers.

LIST OF EXPERIMENTS

1. Study of laboratory equipments used in Environmental Biotechnology lab.
2. Preparation of stocks solutions.
3. To perform the waste Water Sampling by Random Sampling Method
4. Estimation of Biological Oxygen Demand (BOD) of waste water.
5. Estimation of Chemical Oxygen Demand (COD) of waste water.
6. Determination of DO of waste water sample
7. Determination of hardness of a given sample by using EDTA method
8. Determination total dissolved solid, total suspended solids and total solids in a given water sample.
9. Determination of acidity and alkalinity of given water sample.
10. Estimation of optimum dosage of ferric chloride for removal of suspended matter
11. Nitrogen estimation by Kjeldahl method,
12. To determine the amount of total Coliform in the water sample
13. Estimation of cellulose by spectrophotometric method.
14. To determine the chloride content of a given water sample
15. Microbiological characterization of wastewater sample
16. Visit to nearby Waste water treatment plant.

LAB MANUAL/ REFRENCE BOOK

1. A Practical Guide to Environmental Biotechnology by **Patra**, J.K., **Das**, G., **Das**, S.K., **Thatoi**, H., SpringerNature Singapore Pte Ltd 2020.
2. Environment Biotechnology, theory and Lab Practises (1st Ed) by Debajit Borah , Global Vision PublishingHouse, New Delhi,2013.
3. Environmental Microbiology: A laboratory Manual by Ian L Pepper, Charles P Gebra Academic Press, 1995.

PLANT BIOTECH LAB (BTP-014)

L:T:P::0:0:2 **Credits-1**

COURSE OBJECTIVES

To introduce the hands-on descriptions of practical knowledge, required for dealing with plant cell and tissue cultures in vitro and to prepare students capable to micropropagation, organogenesis and its culture methods under in vitro conditions.tc with the help of related instruments and devices.

COURSE OUTCOMES:

At the end of the course, the student should be able to:

1. Formulate, analyze and solve a multilevel laboratory problem in Plant biotechnology lab.
2. Demonstrate experimental observation of callus, suspension and seed culture of explants.
3. Analyze the concept of sterilization, asceptic conditions for plant tissue culture and micro propagation methods through meristem culture in lab.
4. Handle various experiments in the Agricultural field, Plant biotech and Plant tissue culture.
5. Think creative and scientific and motivational skills those are essential for engineers.

LIST OF EXPERIMENTS:

1. Demonstration of gel electrophoresis techniques.
2. Requirements for Plant Tissue Culture Laboratory.
3. Sterilization techniques and Inoculation of various explants
4. Preparation of MS nutrient medium
5. Aseptic manipulation of various explants.
6. To induce callus from explant
7. Micropropagation of important crops, hardening and acclimatization of regenerated plants.
8. To isolate embryos of *Cicer arietinum* and perform *in-vitro* culture
9. To perform for somatic embryogenesis in carrot.
10. Culture of protoplast
11. Preparation and fusion of protoplasts.
12. To investigate the effect of different stresses on seed germination and plant growth
13. To investigate the protective effects of plant extracts on laboratory animals.
14. *Agrobacterium tumefaciens*-mediated plant transformation.
15. To perform RAPD

LAB MANUAL/ REFRENCE BOOK

1. Clark, Melody S., ed. Plant molecular biology—a laboratory manual. Springer Science & Business Media, 2013.
2. Giri, C. C., and Archana Giri. Plant biotechnology: practical manual. IK International Pvt Ltd, 2007.
3. Chawla, H. S., and H. S. Chawla. Plant biotechnology: laboratory manual for plant biotechnology. Oxford and IBH Publishing Company Pvt. Limited, 2004.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY
(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)
Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

B.TECH
(Biotechnology)
4TH Year

Effective From – Session 2025-26

SEMESTER-VII												
Sl. No.	**Subject Codes**	**Subject**	**Periods**			**Evaluation Scheme**					**Subject Total**	**Credit**
						Sessional Exam			**ESE**			
			L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1.	AHT014/AHT015	Rural Development Administration & Planning /Project Management and Entrepreneurship	3	1	0	30	20	50	100		150	
2.	BTT063-066	Departmental Elective-4 BTT-063: Bioreactor Design BTT-064: Bioenergetics BTT-065: Biosensor BTT-066: Biofuel and Alcohol Technology	3	0	0	30	20	50	100		150	3
3.	BTT067-070	Departmental Elective-5 BTT-067: Metagenomics BTT-068: Molecular Pharming BTT-069: Bioprospecting BTT-070: Biotechnology &Entrepreneurship Development	3	0	0	30	20	50	100		150	3
4.	XXX-0XX	Open Elective-2[#]	3	0	0	30	20	50	100		150	3
5.	BTP 015	Project Seminar	0	0	2			50			50	1
6.	BTP 016	Design Project	0	0	4			100			100	2
7.	BTP 017	Mini Project-III or Internship-III*	0	0	2			50			50	1
8.	AHT017	Disaster Management	3	0	0		50	50	100		150	3
9.	AHT018	Audit Course (Innovation and Problem Solving)										
10.	GP07	General Proficiency						50				
		Total	**12**	**1**	**12**						**900**	**19**
11.		**Minor Course (Optional)**	3	1	0	30	20	50	100			**4**
*The Internship-III (4-6 weeks) conducted during summer break after VI semester and will be assessed during VII semester												
2[#]: Select open elective subject from other Departments.												
MOOCs course												

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week, **CT**-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance, **PS-**Practical Sessional Marks, **ESE**-End Semester Examination, **TE**- Theory Examination Marks, **PE**- Practical External Examination Marks

VIII												
S. No.	**Subject Codes**	**Subject Name**	**Periods**			**Sessional Exam**			**ESE**		**Subject Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1.	AHT015/AHT014	Project Management and Entrepreneurship/ Rural Development Administration & Planning	3	0	0	30	20	50	100		150	3
2.	BTT071-074	Departmental Elective-6 BTT071: Drug Delivery and Drug Designing BTT072: Vaccine Technology BTT073: Cancer Biology BTT074: Fundamental of nanobiotechnology	3	0	0	30	20	50	100		150	3
3.	XXX-0XX	Open Elective-3#	3	0	0	30	20	50	100		150	3
4.	XXX-0XX	Open Elective-4#	3	0	0	30	20	50	100		150	3
5.	BTP018	Project	0	0	12			100		200	300	6
6.	GP08	General Proficiency						50				
7.		**Total**	**12**	**0**	**14**						**900**	**18**
8.		**Minor course (Optional)**	3	1	0	30	20	50	100			**4**
9.	MOOCs course											
3#, 4#: Select open elective subject from other Departments.												

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week, **CT**-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance, **PS-**Practical Sessional Marks, **ESE**-End Semester Examination, **TE-** Theory Examination Marks, **PE**- Practical External Examination Marks

Rural Development: Administration and Planning (AHT-014)

L:T:P:: 3:1:0 **Credits-3**

Course Objectives

This course enables the students to:

1. Gain knowledge on the concepts related to administration, its importance and various approaches of Development Administration.
2. Gain skills on New Public Management, Public Grievances and Redressal Mechanisms, Accountability and Transparency in Administration and e-governance in the rural development sector.
3. Develop their competency on the role of Bureaucracy in Rural Development.

Course Outcomes

After completion of the course student will be able to:

1. Students can understand the definitions, concepts and components of Rural Development.
2. Students will know the importance, structure, significance, resources of Indian rural economy.
3. Students will have a clear idea about the area development programmes and its impact.
4. Students will be able to acquire knowledge about rural entrepreneurship.
5. Students will be able to understand about the using of different methods for human resource planning.

Course Contents

UNIT-I: **(8 hours)**

Rural Planning & Development: Concepts of Rural Development, Basic elements of rural Development, and Importance of Rural Development for creation of Sustainable Livelihoods, An overview of Policies and Programmes for Rural Development- Programmes in the agricultural sector, Programmes in the Social Security, Programmes in area of Social Sector.

UNIT-II: **(8 hours)**

Rural Development Programmes: Sriniketan experiment, Gurgaon experiment, Marthandam experiment, Baroda experiment, Firkha development scheme, Etawapilot project, Nilokheri experiment, approaches to rural community development: Tagore, Gandhi etc.

UNIT-III: **(8 hours)**

Panchayati Raj & Rural Administration: Administrative Structure: bureaucracy, structure of administration; Panchayati Raj Institutions Emergence and Growth of Panchayati Raj Institutions in India; People and Panchayati Raj; Financial Organizations in Panchayati Raj Institutions, Structure of rural finance, Government & Non- Government Organizations / Community Based Organizations, Concept of Self help group.

UNIT-IV: **(8 hours)**

Human Resource Development in Rural Sector: Need for Human Resource Development, Elements of Human Resource Development in Rural Sector Dimensions of HRD for rural development-Health, Education, Energy, Skill Development, Training, Nutritional Status access to basic amenities – Population composition.

UNIT-V: **(8 hours)**

Rural Industrialization and Entrepreneurship: Concept of Rural Industrialization, Gandhian approach to Rural Industrialization, Appropriate Technology for Rural Industries, Entrepreneurship and Rural Industrialization- Problems and diagnosis of Rural Entrepreneurship in India, with special reference to Women Entrepreneurship; Development of Small Entrepreneurs in India, need for and scope of entrepreneurship in Rural area.

Text Books/References:

1. Corporate Social Responsibility: An Ethical Approach - Mark S. Schwartz.
2. Katar Singh: Rural Development in India – Theory History and Policy.
3. Todaro M.P. Economic Development in III World war.
4. Arora R.C – Integrated Rural Development in India.
5. Dhandekar V.M and Rath N poverty in India.
6. A.N. Agarwal and Kundana Lal: Rural Economy of India.
7. B.K.Prasad: Rural Development-Sarup & Son's Publications.

PROJECT MANAGEMENT & ENTREPRENEURSHIP (AHT-015)

L:T:P:: 3:1:0

Credits-3

Course Objectives:

The course should enable the students to:

1. Understand the concepts of Project Management for planning to execution of projects.
2. Understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
3. Be capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.
4. Understand the concepts of Entrepreneurship, role of entrepreneur in economic development, steps for establishing an enterprise.

Course Outcomes:

After completion of the course student will be able to:

1. Understand project characteristics and various stages of a project.
2. Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.
3. Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.
4. Describe Entrepreneurship, Examine role of entrepreneur in economic development.
5. Describe the steps to establish an enterprise.

Course Contents

UNIT-I: **(8 hours)**

Entrepreneurship: Entrepreneurship: need, scope , Entrepreneurial competencies & traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (Mc Clellend's Achievement motivation theory), conceptual model of entrepreneurship , entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes.

UNIT-II: **(8 hours)**

Entrepreneurial Idea and Innovation: Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities, Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model & Organizational Effectiveness.

UNIT-III: **(8 hours)**

Project Management: Project management: meaning, scope & importance, role of project manager; project life- cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal, Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.

UNIT-IV: **(8 hours)**

Project Financing: Project cost estimation & working capital requirements, sources of funds, capital budgeting, Risk & uncertainty in project evaluation , preparation of projected financial statements viz. Projected balance sheet, projected income statement, projected funds & cash flow statements, Preparation of detailed project report, Project finance.

UNIT-V: **(8 hours)**

Social Entrepreneurship: Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures.

Case study and presentations: Case study of successful and failed entrepreneurs. Power point presentation on current business opportunities..

Text Book:

1. Innovation and Entrepreneurship by Drucker, P.F.; Harperand Row. H.;PHI.
2. Business, Entrepreneurship and Management: Rao, V.S.P.;Vikas
3. Entrepreneurship: Roy Rajeev.
4. Text Book of Project Management: Gopal krishnan, P. and Ramamoorthy,V.E.; McMill.
5. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.;PHI.
6. Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.;MGH.

DEPARTMENTAL ELECTIVE-4

BIOREACTOR DESIGN (BTT-063)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To provides exposure for the design and operation of various industrial bioreactors
2. Analyze the design and operation of air driven bioreactors

COURSE OUTCOMES

After completion of the course, student will be

1. Able to Strengthen the basic notions of bioreactor design
2. Expand knowledge on various modes of operation of industrial bioreactors for microbial, plant and animal cell culture system

SYLLABUS

UNIT-I **(8 Hours)**

Basics and importance of bioreactors, Guidelines for bioreactor design, Mechanical aspects of bioreactor design, Requirements for construction of a bioreactor, Development of bioreactors

UNIT-II **(8 Hours)**

Scale-up of bioreactors-Criteria of scale-up, Scale-up methods, Generalized approaches to scale-up in combination of methods, Common operations in bioreactors.

UNIT-III **(8 Hours)**

Design and construction of Bubble column fermenter, Airlift bioreactors: Design and construction of the airliftloop reactor ,Hydrodynamics – Three phase flow – Mixing – Oxygen transfer, Design and operation of fluidized bed bioreactor

UNIT-IV **(8 Hours)**

Design and Operation of Sequence batch reactor, Design and Operation of bioreactor with recycle Design of bioreactors for Solid-state fermentation

UNIT-V **(8 Hours)**

Design and Operation of Membrane bioreactor, Design and Operation of Immobilized enzyme bioreactor, Design and Operation of Hollow fiber bioreactor, Design and Operation of Plant cell bioreactor design

TEXT /REFERENCE BOOKS:

1. Scragg. H., "*Bioreactors in Biotechnology*", Ellis Horwood series, 1991.
2. Panda. T., "*Bioreactors: Analysis and Design*", McGraw Hill Education (India) Private Limited, 2011
3. Riet. K. V., Tramper. J., "*Basic Bioreactor Design*", 2nd ed., Marcel Dekker, Inc., New York, 1991.

BIOENERGETICS (BTT-064)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To make students understand that thermodynamics principle is applicable to cells.
2. To know the significance of ATP as energy currency of cell.
3. To make student understand that biotransformation and enzyme-catalyzed metabolic pathways obey physical and chemical laws to maintain and perpetuate life forms.

COURSE OUTCOMES

After completion of the course, the students:

1. Will realize that all the cellular/biochemical changes obey the basic thermodynamic principles.
2. Can explain release of free energy during catabolic breakdown of the substances and its utilization during anabolic pathways
3. Can illustrate the mechanism of various types of transport system in biological membrane

SYLLABUS

UNIT-I **(8 Hours)**

Bioenergetics and thermodynamics: biological transformation reaction obeying laws of thermodynamics, concept of standard free energy change, Structure and properties of ATP and other high energy compounds, Coupling reactions of ATP and NDP (nucleotide di phosphate); Biological oxidation reduction reactions.

UNIT-II **(8 Hours)**

Biological membrane: structure, composition, function, fluid mosaic model, permeability, properties, passive transport active transport and their types with details and examples. facilitated transport, energy requirement, mechanism of Na^{+}/K^{+}, glucose and amino acid transport.

UNIT-III **(8 Hours)**

Energetics of Metabolic Pathways; Energy Coupling (ATP & NADH); Stoichiometry and energetic analysis of Cell Growth and Product Formation - elemental Balances, Degree of reduction concepts; available-electron balances; yield coefficients; Oxygen consumption and heat evolution in aerobic cultures; thermodynamic efficiency of growth.

UNIT-IV **(8 Hours)**

Electron Flow as source of ATP Energy, Site of Oxidative Phosphorylation, ATP synthetase, Electron-Transferring Reactions, Standard Oxidation, Electron Carrier, electron transport complexes, Incomplete reduction of Oxygen, Mechanism of Oxidative Phosphorylation, Oxidation of Extra mitochondrial NADH, ATP yield and P: O Ratio, Role of Electron Transport Energy, Respiratory Inhibitors, Regulatory control among Glycolysis, the Citric Acid Cycle and Oxidative Phosphorylation.

UNIT-V **(8 Hours)**

Photosynthesis in aerobic conditions: Structure of chloroplast, Thylakoid membrane of chloroplast, Discovery of basic reactions of photosynthesis basic reactions of photosynthesis Structure of chlorophyll, Absorption spectrum of chlorophyll a and chlorophyll b Properties of photosystem I and photosystem II Efficiency of photosynthesis Hill reaction, Metabolism of Nitrogen containing compounds: Nitrogen fixation, Photosynthesis in anaerobic conditions

BIOENERGETICS (BTT-064)

L:T:P::3:0:0 **Credits-3**

TEXT /REFERENCE BOOKS:

1. Introduction to Chemical Engineering thermodynamics by Smith and Vannes (McGraw Hill).
2. Chemical engineering thermodynamics by Y.V.C. Rao (New age international).
3. Engineering Thermodynamics by J. B. Hawkins (John Wiley Publication).
4. Lehninger, Nelson and Cox, Principles of Biochemistry, 4 Edition, W.H.Freeman & Company, 2004.
5. Voet & Voet, Fundamentals of Biochemistry, Upgrade Edition, Wiley, 2002
6. Lubert Stryer, Biochemistry, 4th Edition, W.H.Freeman and Company, 1995

BIOSENSOR (BTT-065)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. This course aims to provide understanding of biomolecules as recognition elements for detection of a particular analyte.
2. To develop understanding of bioelectronic devices.
3. To understand use of biological elements such as proteins in place of silicon chips.

COURSE OUTCOMES

1. On the completion of the course, the students will be able to:
2. Articulate the fundamentals of biosensors and their electrochemistry.
3. Distinguish and select between various Transducers in Biosensors.
4. Select and apply Biosensors for food, medical, agriculture and other sectors.
5. Apply various Bioelectronic devices for human welfare.

SYLLABUS

UNIT-I **(8 Hours)**

Overview of biosensors and their electrochemistry: Molecular reorganization: Enzymes, Antibodies and DNA, Modification of bio recognition molecules for Selectivity and sensitivity, Fundamentals of surfaces and interfaces.

UNIT-II **(8 Hours)**

Transducers in Biosensors: Various types of transducers; principles and applications - Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor, Impedimetric, Chemilluminiscene - based Biosensors

UNIT-III **(8 Hours)**

Application of enzymes in analysis; design of enzyme electrodes and their application. Application and uses of Biosensors: Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food. Low cost - biosensor for industrial processes for online monitoring; biosensors for environmental monitoring.

UNIT-IV **(8 Hours)**

Bioelectronics: Bioinstrumentation and bioelectronics devices: Optical Biosensors based on Fiber optics, FETs and Bio-MEMS. Introduction to Chemometrics, Biosensor arrays; Electronic nose and electronic tongue, Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly.

UNIT-V **(8 Hours)**

Design for a biomolecular photonic computer: Assembly of photonic biomolecular memory store; Information processing; commercial prospects for biomolecular computing systems.

TEXT /REFERENCE BOOKS:

1. Brian R Eggins - Biosensors an Introduction , First edition, John Wiley &SonsPublishers, 1996.
2. Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, Firstedition, Marcel Dekker, Inc, 1991.
3. Elizabeth A Hall - Biosensors, First Edition, Open University, Milton Keynes,1990.
4. Graham Ramsay - Commercial Biosensors, First edition, John Wiley & Sons, Inc.1998.
5. Tran Minh Canh - Sensor Physics & Technology - Biosensors , First Edition,Champan& Hall, 1993.

BIOFUEL AND ALCOHOL TECHNOLOGY (BTT-066)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. This course aims to provide different strategies to convert biomass to biofuels
2. To provide the review of the available and advanced technologies and how these could meet the growing demand for energy in the future
3. To assess environmental impacts and economy of biofuels

COURSE OUTCOMES

After completing this course, the students will be able to:

1. Summarize the basic fundamental concepts of biofuel and bioenergy.
2. Evaluate clearly and concisely the benefits and problems relating to the production of biofuels from biomass.
3. Apply approaches in biofuels including Microbial fuel cell, Advanced power plant concepts (IGCC) and etc.
4. Calculate the energy generating potential of biomass as an energy source
5. Investigate the potential of biodiesel as an engine fuel.
6. Critically assess the economy of bio-renewable resources and environmental impact of the bioeconomy**.**

SYLLABUS

UNIT-I **(8 Hours)**

Energy perspective: Current methods, Biomass possibilities. Fundamental concepts in understanding biofuel and bioenergy production: Mass Balances, Energy Balances, Thermodynamics, Organic compounds, Chemistry of plant materials resources.

UNIT-II **(8 Hours)**

Fossil versus renewable energy. Production of biorenewable resources**:** Herbaceous crops,Woody crops**,** Algae. Conversion of biomass into heat and power**:** Direct combustion**,** Thermal gasification**,** Anaerobic digestion. Processing of biomass into chemicals and fuels: Sugars, Alcohols, Biodiesel, Thermochemical conversion, Fischer Tropsch Fuels

UNIT-III **(8 Hours)**

Combustion Engines, Turbines and Fuel Ratings. Microbial fuel cell, Advanced power plant concepts (IGCC, NGCC), Gas to liquid processes (GTL), Carbon dioxide capture and storage, Chemical Looping.

UNIT-IV **(8 Hours)**

Comparison of Bio-energy Sources, Biorefinery, Biofuels for Transportation, Vegetable Oils as Engine Fuels.Biodiesel as Engine Fuel:Engine Emissions from Biodiesel, Biodiesel production by using various microorganisms, algae and Transesterification process, methods of biodiesel production.

UNIT-V **(8 Hours)**

Environmental impact of the bioeconomy**:** Land use**,** Pollution**,** Climate change. Economics of biorenewable resources**:** Feedstock costs**,** Capital costs**,** Operating costs. Economics of biogas plants. Algae biofuels: versatility for the future of bioenergy.

TEXT /REFERENCE BOOKS:

1. C. M. Drapcho, N. P. Nhuan, T. Walker, Biofuel Engineering Process Technology, McGraw Hill 2008
2. D. M. Mousdale, Biofuels, CRC Press 2008
3. Carlson, R. 2007. Laying the foundations for a bio-economy. Systems and Synthetic Biology.
4. Gaskell, G. et al. 2011. The 2010 Eurobarometer on the life sciences. Nature Biotechnology. 29:113-114

DEPARTMENTAL ELECTIVE-5

METAGENOMICS (BTT-067)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To provide focus on next generation DNA sequencing technology to describe the ecological roles of microbial communities in different environments.
2. It also provides how the metabolic functions, taxonomic distribution, diversity, evenness and species richness of microbial communities varies across environment.

COURSE OUTCOMES

After completion of the course

1. Students can use metagenomic data to describe the taxonomic make-up, functional potential and ecological processes of microbial communities from a range of environments
2. Students can apply next generation sequencing technology.
3. Students can assemble and annotate genomes by identifying genes

SYLLABUS

UNIT-I **(8 Hours)**

Environmental Metagenomics– Introduction; Pure culture and in consortium ;Cultivable and Non-cultivable microbial analysis, Molecular fingerprinting techniques, Stable isotope probing (SIP); Suppressive subtractive hybridization (SSH);Microarrays & Metagenome sequencing; Next-generation sequencing approaches to metagenomics.

UNIT-II **(8 Hours)**

Protein separations before digestion; One-dimensional SDS-PAGE, Two dimensional SDS-page, Problems with 2d-SDS-PAGE, Preparative IEF, High performance liquid chromatography; Protein separations after digestion: Masss pectrometers for protein and peptide analysis, Instrumentation, MALDI-TOF-MS. The TOF mass analyzer, Pros and cons of MALDI, Protein identification by peptide mass fingerprinting, Peptide mass fingerprinting: analytical approach, Peptide mass fingerprinting: complications, Software tools for peptide mass fingerprinting, Finding the matches, Applications of Proteomics in Metagenomics; Challenges with Metagenomic Analysis

UNIT-III **(8 Hours)**

Cataloging microbes**:** phylogenetic tree and construction - Construction of a metagenomics library; Analysis of Metagenomic Libraries; Sequence-based Metagenomics Analysis; Function-based Metagenomics Analysis; Phylogenetic analysis and Comparative genomics Softwares & Tools.

UNIT-IV **(8 Hours)**

Metagenomic analysis of soil microbial communities; Metagenomic analysis of marine microbial communities; Metagenome of the Microbial Community in Acid Mine Drainage ; Metagenomic Analysis of Bacteriophage; Metagenomics and Its Applications to the Study of the Human Microbiome; Archaea Metagenomics: Bioprospecting Novel Genes and Exploring New Concepts.

UNIT-V **(8 Hours)**

Application of Metagenomics to Bioremediation; Applications of Metagenomics for Industrial Bioproducts; Escherichia coli host engineering for efficient metagenomic enzyme discovery; Next-generation sequencing approaches to metagenomics; Stable isotope probing: uses in metagenomics; DNA sequencing of uncultured microbes from single cells

METAGENOMICS (BTT-067)

L:T:P::3:0:0 **Credits-3**

TEXT /REFERENCE BOOKS:

1. Joanna R. Freeland, Heather Kirk, Stephen Petersen, "*Molecular Ecology*", McGraw Hill, 2nd Edition "2012.
2. Beebee T.J.C., D G. Rowe," *An Introduction to Molecular Ecology*", Mc Graw Hill, 2004

MOLECULAR PHARMING (BTT-068)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. Students will learn about molecular farming an emerging branch of plant biotechnology
2. They will know about the range of products from molecular farming such as carbohydrates, fats, proteins, secondary products.
3. They will acquire knowledge about various molecular approaches and strategies of molecular farming.
4. They will have illustrative knowledge of Plant as bio factories and chloroplast as clean high-level expression system for molecular farming

COURSE OUTCOMES

After completion of the course

1. Students will be able to create awareness about the production of pharmaceutical proteins in plants
2. Students will develop strategies for modification of plants for production of important molecules
3. Students can take decision to select the expression system in plants for various proteins and enzymes

SYLLABUS

UNIT-I **(8 Hours)**

Introduction: Definition and common perception of molecular farming; history, molecular farming hosts, transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance & advantages of plant-based molecular farming.

UNIT-II **(8 Hours)**

Various molecular approaches & strategies relevant to molecular farming , Major targets for carbohydrate and lipid molecular farming; Production of carbohydrates: increased starch amount, amylose-free starch, high-amylose starch, cyclodextrins, fructans, trehalose; Production of lipids: medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, polyunsaturated fatty acids having pharmaceutical and nutraceutical values.

UNIT-III **(8 Hours)**

Genetically engineered plants as protein factories, Enzymes for industrial and agricultural uses, medically related proteins-antibodies (plantibodies), subUNIT-Vaccines, protein antibiotics; The oleosin system: hirudin and insulin production, production of biopharmaceuticals in plants

UNIT-IV **(8 Hours)**

Chloroplast: a clean high-level expression system for molecular farming based on single or multiple transgenes. chloroplast derived human antibodies, biopharmaceuticals, Human Serum Albumin, Human insulin like growth factor-1, Human interferon, Antimicrobial peptides, chloroplast derived vaccine antigens, cholera toxin B subunit, *Bacillus anthracis* protective antigen, *Yersinia pestis* F1-V fusion antigen, Canine Parvovirus VP2 protein.

UNIT-V **(8 Hours)**

Production of Biodegradable Plastics in Plants: Various gene functions involved in the production of polyhydroxy butyrate (PHBs) &polyhydroxyalkenoate co-polymers; Strategies for production of biodegradable plastics in plants. Critical evaluation on various case studies of molecular farming & their future prospects; Economic, regulatory and biosafety considerations for molecular farming.

MOLECULAR PHARMING (BTT-068)

L:T:P::3:0:0 **Credits-3**

TEXT /REFERENCE BOOKS:

1. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Second Edition, Oxford University Press (2008).
2. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).
3. Barnum, S.R., Biotechnology-an Introduction, Thompson Brooks/Cole (2007).
4. Primrose, S.B., Molecular Biotechnology, Second Edition, Panima Publishing Corporation

BIOPROSPECTING (BTT-069)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To introduce the concept of bioprospecting.
2. To provide knowledge about medicinal, nonmedicinal plants, marine and microbial bioprospecting and their applications.

COURSE OUTCOMES

After completion of the course

1. Student will have and create basic awareness about bioprospecting.
2. Student will have knowledge about different types of bioprospecting: plant, marine and microbial.
3. Students can illustrate the application of different field of bioprospecting.

SYLLABUS

UNIT-I **(8 Hours)**

Bioprospecting: Definition, Introduction, Current practices in Bioprospecting for conservation of Biodiversity and Genetic resources. Bioprospecting Act: Introduction, Phases of Bioprospecting, Exemption to Act. Fields of Bioprospecting.

UNIT-II **(8 Hours)**

Medicinal Plants Bioprospecting/ Pharmaceutical Bioprospecting: for new drugs, assays in Bioprospecting. Antioxidant assay – NO free radical scavenging assay, Antigenotoxicity assay – MTT assay, Antiviral activities of plants – SRB assay.

UNIT-III **(8 Hours)**

Origin, evolution, botany, cultivation and uses of Food, Fodder, Fibers, Oil yielding crops, wood and timber, Non-wood forest products(NWFPS): Bamboos, Gums, Dyes, Resins, Fruits etc.

UNIT-IV **(8 Hours)**

Marine Bioprospecting: Sources of marine planktons and their Bioprospecting, Isolation and cultivation of Marine bio resources, Isolation of Marine Yeast and its industrial applications, bioactive chemicals from Seaweeds and their applications.

UNIT-V **(8 Hours)**

Microbial Bioprospecting: Isolation of Microbial metabolites and screening for bioactivity, antimicrobials, pharmacologically active agents of microbial origin, bioprospecting for industrial enzymes, plant growth promoting agents, biotreatment, bioprospecting novel antifoulants and anti-biofilm agents from microbes.

TEXT /REFERENCE BOOKS:

1. Joanna R. Freeland, Heather Kirk, Stephen Petersen, “Molecular Ecology”,McGraw Hill, 2nd Edition “2012.
2. Beebee T.J.C., D G. Rowe,” An Introduction to Molecular Ecology”, McGraw Hill, 2004.
3. Diana Marco Universidad Nacional de Cordoba, Argentina, “Metagenomics:Theory, Methods and Applications”, Caister Academic Press, 2010.
4. Diana Marco Universidad Nacional de Cordoba, Argentina “Metagenomics:Current innovations and Future Trends”, Caister Academic Press, 2011

BIOTECHNOLOGY & ENTREPRENEURSHIP DEVELOPMENT (BTT-070)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To make student good communicator and negotiator for being good entrepreneur
2. To impart basic knowledge how biotechnology can boost up entrepreneurship development
3. To use research and development for developing entrepreneurial enterprise
4. To tell students different avenues of entrepreneurship in biotechnology discipline
5. To increase confidence levels so that the students will be good entrepreneur

COURSE OUTCOMES

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

1. Become good communicator with proficient skills
2. Have full knowledge of entrepreneurship development through biotechnology
3. Start new business
4. Helpful in employment generation
5. Become real stake holder of national GDP

SYLLABUS

UNIT-I **(8 Hours)**

Basics of Entrepreneurship, Entrepreneurial traits, Need to commercialize biotechnology for entrepreneurship. Development process, success rates and costs etc., Creating and marketing the image of the biotechnology company. Art of negotiation& effective communication

UNIT-II **(8 Hours)**

Entrepreneurial Motivation, Role of venture capitalism, business plan, selection of CEO and personnel, real estate for a biotech start-up., Government assistance for developing new start- ups ,Management portray and role of a biotechnology manager, technology decision-making and resource decision-making etc., Product marketing decision.

UNIT-III **(8 Hours)**

Role of research & development, university-industry technology transfer arrangements, benefits of a biotech company. Case studies of research extension and successful developed organization

UNIT-IV **(8 Hours)**

Positioning, power and importance of a company name, product, workable marketing and the strength of distribution. Effective advertising and marketing, marketing research and cosumer behaviour, Case studies of successful launching of bioproduct

UNIT-V **(8 Hours)**

Opportunities international marketing and lessons to be learned, Indian and foreign prospective of biotechnology and current challenges for the biotechnology-based products. Case studies of international marketing of life science based products

TEXT /REFERENCE BOOKS:

1. Positioning by All Rise and Jack Trout (1986), Warner Books.
2. Biotechnology: The science & the business by V. Moser & R.E. Cape (1999) Harwood.
3. Entrepreneurship Development.2014.S.S.Khanka.S Chand & Co.
4. http://www.startupindia.gov.in
5. Latest review articles and papers on the subject.

DISASTER MANAGEMENT (AHT-017)

L:T:P:: 3:0:0 **Credits-3**

COURSE OBJECTIVES:

The course should enable the students to:

1. To introduce the students to various types of natural and manmade disasters.
2. To understand causes and impact of disasters.
3. To understand approaches of Disaster Management .
4. To build skills to respond to disaster.

COURSE OUTCOMES:

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

1. To provide students an exposure to disasters, their significance and types.
2. To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
3. To understand approaches of Disaster Management.
4. To build skills to respond to disaster.

Unit-1 Introduction to Disasters

Concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks). Disaster Types, Trends, Causes, Consequences and Control of Disasters, Geological Disasters; Hydro-Meteorological, Biological, Technological and Manmade Disasters.

Unit-2 Disasters: Classification, Causes, Impacts

(Including social, economic, political, environmental, health, psychosocial, etc.)
Differential impacts-in terms of caste, class, gender, age, location, disability. Global trends in disasters urban disasters, pandemics, complex emergencies, Climate change.

Unit-3 Approaches to Disaster Risk Reduction:

Disaster cycle- its analysis, Phases, Culture of safety, prevention, mitigation and preparedness, community based DRR, Structural- nonstructural measures, roles and responsibilities of community, Panchayati Raj Institutions/ Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders.

Unit-4 Inter-relationship between Disasters & Development

Factors affecting Vulnerabilities, differential impacts, Impact of Development projects such as dams, embankments, changes in Land-use etc. Climate Change Adaptation. Relevance of indigenous knowledge, appropriate technology and local resources

Unit-5 Disaster Risk Management in India:

Hazard and Vulnerability profile of India. Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, plans, programmes and legislation)

Text/Reference Books:

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.
3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.
4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.
5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD.

Innovations and Problem Solving (AHT-018)

L:T:P: 2:1:0 **Credits-0**

PREREQUISITE:
Basic Engineering Aptitude

COURSE OBJECTIVES:
This subject aims to inculcate critical thinking abilities and application of knowledge for problem solving. It will expose the students with various simple methods and practices that are essential to development of new systems, problem formulation and problem solving in technical and non-technical fields. This course will stimulate the work environment of the modern day engineers and technologists by familiarizing them with the state-of-the art results, design and analysis tools in various disciplines, the ability to extract relevant information to formulate and solve problems arising in practice.

COURSE OUTCOMES:
The course will enable students to,

1. Identify the market and value proposition
2. Carry out rigorous and accessible formulation to problems
3. Solutions via reducing the search space
4. Eliminating tradeoffs to reduce dimension of optimization problems
5. Execution through developing strategies for experiment, construction and monetization.
6. Simulate the work environment of the modern engineer or knowledge worker in general.

Unit – I **8 Hrs**
Introduction to Critical Design Thinking

- Understanding critical thinking, creative thinking, and problem solving through examples.
- New ways to solve problems.

Unit – II **8 Hrs**
Theory of Inventive Problem Solving

- Examples of inventive problem solving,
- Era of technical systems,
- Science of inventing,
- Art of inventing,
- Amazing world of tasks

Unit – III **8 Hrs**
Logic and Tools for Creativity and Clarity of Thought

- TRIZ tools for creativity and solutions,
- World's known solutions,
- Fundamentals of Problem solving,
- Thinking in Time and Scale,
- Uncovering and solving contradictions,
- Fast Thinking with ideal outcome.

Unit – IV **8 Hrs**
Modeling for Problem Solving

- Moving from problem to ideal final result,
- Tradeoffs and inherent contradictions,
- Invisible reserves,
- Law of increasing ideality,
- Evaluation of solutions,
- Enriching models for problem solving.

Unit – V **8 Hrs**

Principles for Innovation

- General review,
- Segmentation, Separation,
- Local quality, symmetry change, merging and multifunctionality,
- Nested doll and weight compensation,
- Preliminary counteraction, preliminary action, and beforehand compensation,
- Equipotentiality, the other way around and curvature increase,
- Dynamic parts, partial or excessive actions, dimensionality change, mechanical vibration
- Periodic action, continuity of useful action, and hurrying,
- Blessing in disguise, feedback, and intermediary,
- Self service, copying, cheap disposables, and mechanical interaction substitution
- Pneumatics and hydraulics, flexible shells and thin films, and porous materials,
- Optical property changes, homogeneous, and discarding and recovering,
- Parameter changes, phase transitions, and thermal expansion,
- Strong oxidants, inert atmosphere, and composite materials,
- How to select most suitable principle out of 40 ways to create good solutions

References

1. ABC-TRIZ Introduction to Creative Design Thinking with Modern TRIZ Modeling by Michael A. Orloff
2. TRIZ And Suddenly the Inventor Appeared TRIZ, the Theory of Inventive Problem Solving by GenrichAltshuller
3. TRIZ for Engineers Enabling Inventive Problem Solving by Karen Gadd
4. Simplified TRIZ New Problem Solving Applications for Engineers and Manufacturing Professionals by Rantanen K., Domb E.

DEPARTMENTAL ELECTIVE-6

DRUG DELIVERY AND DRUG DESIGNING (BTT-071)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To explore the process of drug development from target identification to final drug selection
2. The student will acquire knowledge of the techniques of drug designing

COURSE OUTCOMES:

Students will be able to

1. Demonstrate an awareness of the current approaches to global drug discovery and their advantages & limitations
2. Demonstrate an understanding of the steps involved in the drug discovery and design process

SYLLABUS

UNIT-I **(8 Hours)**

Overview of drug discovery process, Physicochemical Properties in Relation to Biological Action – Effects of route of administration, sites of loss, solubilities and partition coefficients (Ferguson, Hansch), Drug-receptor interactions, Steric features of drugs, The drug receptor, structure-Activity Relationships, Representatives physicochemical properties as relation to biological action.

UNIT-II **(8 Hours)**

Drug targets classification-DNA, RNA, post-translational, processing enzymes, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors, neuropeptide receptors, ion channels (monomeric multi-transmembrane) proteins, ligand-gated ion channels (oligomeric trans membrane proteins), transporters (multi-trans membrane proteins, Validation Strategies.

UNIT-III **(8 Hours)**

Drug Design Strategies: Structure-based design-Docking and de novo methods, Design and development of combinatorial libraries for new lead generation, The molecular diversity problem, drug characterization – principles of equilibria, diffusion and kinetics, pre-formulation: pKa, partition coefficient, solubility, dissolution, chemical stability, and permeability, optimization of ADME characteristics, physico-chemical properties calculation, chemometrics in drug design.

UNIT-IV **(8 Hours)**

QSAR: Statistical techniques behind QSAR, classical QSAR, molecular descriptors 3D QSAR and COMFA, drug design to discovery and development, drug metabolism, toxicity and pharmacokinetics, toxicology considerations, problems and drawbacks on drug discovery and development, Conventional delivery methods; Pharmacokinetic models; Polymeric controlled release systems, Dose Response curves.

UNIT-V **(8 Hours)**

Survey of various Drug Classes – Anaesthetics (general, local), Analgesics, Neurotransmitters (adrenergic, cholinergic effects; psychopharmacology), CNS depressants (sedative/hypnotic, major/minor tranquilizers), CNS, Stimulants, Antibiotics (especially β-lactam), Steroids- Mechanism of action and applications.

TEXT /REFERENCE BOOKS:

1. Novel Drug Delivery Systems. 2nd Ed., Drugs and the Pharmaceutical Sciences Volume 50, Maccel Dekker, 1992.
2. Novel Drug Delivery Systems. Yie W. Chien. Edition2, illustrated Publisher M. Dekker.
3. Drug Delivery and Targeting For Pharmacists and Pharmaceutical Scientists. Anya M. Hillery, Andrew W. Lloyd, James Swarbrick Editors Anya M. Hillery, Andrew W. Lloyd, James Swarbrick illustrated Publisher, Taylor & Francis.

VACCINE TECHNOLOGY (BTT-072)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To learn the importance and types of different kinds of Vaccines and study various factors that influence vaccine design and development.
2. To understand the nature, scope and transmission of different immune related diseases.

COURSE OUTCOMES

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

1. Demonstrate an understanding of the importance of the factors that influence vaccine design and development.
2. Develop an understanding of how research based discovery has driven vaccine development in current, emerging and,re-emerging infectious diseases.
3. Develop the skills to critically assess the different types of vaccines available and their suitability for different diseases.
4. Demonstrate an understanding of the nature and variability of bacterial and virus antigens relevant to vaccine development.
5. Demonstrate an understanding of the importance of strict quality control and regulation in the vaccine production process, and an awareness of issues associated with the manufacturing of vaccines such as good manufacturing practice.

SYLLABUS

UNIT-I

Short history of vaccination, requirements for induction of immunity, Immunization, Immunization types: active and passive immunization, Rationale of immunization, Adjuvant, Mechanism of adjuvant action, Age of commencement of immunization, Dosage and Dosage spacing, Vaccine schedule, Hazard of immunization., Scope of future vaccine strategies.

UNIT-II

Viral/bacterial/parasite vaccine differences, methods of vaccine preparation, Live, killed vaccine and attenuated, Rationale vaccine design based on clinical requirements, Different types of vaccine: subunit-Vaccine, Recombinant Vaccine, edible vaccine, SubUNIT-Vaccine, antidiotype vaccine, Recombinant DNA and protein based vaccines, plant-based vaccines; Peptide vaccines, conjugate vaccines; Cell based vaccines, reverse vaccinology

UNIT-III

Hypersensitivity: Types of hypersensitivity, IgE-Mediated (Type I) Hypersensitivity, Antibody-Mediated Cytotoxic (Type II), Immune Complex–Mediated (Type III), Type IV or Delayed-Type Hypersensitivity (DTH), Immunity to Infection. Autoimmunity, immunodeficiency; Therapeutic approach for autoimmune disease, Transplantation, Transfusion of immune competent cells, Tumor of immune system, Immunotherapy of cancer, Stem cell therapy;

UNIT-IV

Antigen Sequence analysis, Epitope Mapping, Predictions of Immunogenic peptides of T-Cell and B-Cells. Prediction of HLA binding peptides, Comparative Genomics as a tool for vaccine design, introduction to online epitope databases

UNIT-V

Quality control and regulations in vaccine research, In-vitro experimental validations for predictions of vaccines by software, Animal testing, Rational design to clinical trials, Large scale production, Commercialization, ethics.

TEXT /REFERENCE BOOKS:

1. Medical Microbiology: Mackie and McCartney.
2. Immunology by Janis Kuby.

CANCER BIOLOGY (BTT-073)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To learn the fundamentals of cancer and cell cycle regulation/dysregulation.
2. To know the principle, agents and mechanism of carcinogenesis of metastasis.
3. To understand the role of Oncogenes /tumor suppressor genes and their role in cancer.
4. To understand the Detection and treatment therapies of cancer.

COURSE OUTCOMES

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

1. Explain the cell cycle, its regulation, and how cell cycle dysfunction can lead to cancer.
2. Describe the function of tumor suppressor genes.
3. Clarify how cancer cells escape cell death.
4. Give details on how chronic inflammation and infectious agents can lead to cancer.
5. Explain the role of diet in cancer development and cancer prevention.

SYLLABUS

UNIT-I **(8 Hours)**

Fundamentals of Cancer Biology Regulation of Cell cycle, mutations that cause changes in signal molecules, effectson receptor, signal switches, Tumor Suppression tumour suppressor genes, modulation of cell cycle in cancer. Different forms of cancers, Diet and cancer.

UNIT-II **(8 Hours)**

Principles of Carcinogenesis, Chemical Carcinogenesis, Metabolism of Carcinogenesis, Nature and history of Carcinogenesis, Targets of Chemical Carcinogenesis. Principles of Carcinogenesis II, Principles of Physical Carcinogenesis , X - Ray radiation - mechanism of radiation carcinogenesis.

UNIT-III **(8 Hours)**

Molecular Cell Biology Of Cancer Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth Factor and Growth Factor receptors that are Oncogenes. Oncogenes / Proto Oncogene activity. Growth factors related to transformations.

UNIT-IV **(8 Hours)**

Principles of Cancer Metastasis. Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement Membrane disruption, Three-step theory of Invasion, Proteinases and tumor cell invasion.

UNIT-V **(8 Hours)**

Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection. New Molecules for Cancer Therapy, Different forms of therapy, Chemotherapy, radiation Therapy, and Immuno-therapy: Advantages and Limitations.

TEXT /REFERENCE BOOKS

1. Maly B.W.J. Virology a practical approach, IRL Press, Oxford, 1987. Dunmock N.J and Primrose.S.B.Introduction to modern Virology, Blackwel Scientific Publications.Oxford, 1988.
2. The Biology of Cancer by Robert Weinberg. Garland Science, Taylor& Francis Group, NewYork Cotran R.S, Vinay Kumar, Collins.T, Robbins, S.L., 1999, “Robbin’s Pathologic Basis of Disease”, 6th ed., W.B.Saunders, Philadelphia.
3. Maxwell M. Wintrobe, G.Richard Lee, 1998, 10 Ed, “Wintrobe’s Clinical Haematology”, Lippincott Williams & Wilkins Publishers, New York.
4. Molecular Biology of Cancer by F. Macdonald, C.H.J. Ford, and A.G. Casson;Garland Science / Bios Scientific Publishers.
5. Molecular Biology of Human Cancers by Wolfgang Arthur Schulz, Springer

FUNDAMENTALS OF NANOBIOTECHNOLOGY (BTT-074)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To understand the field of nano-biotechnology.
2. To learn the principles behind nanobiotechnology.

COURSE OUTCOMES

At the end of the course, students will be able-

1. To understand the essential features of biology and nanotechnology that are converging to create the new area of nano-biotechnology.
2. To recognize the structural and functional principles of nano-biotechnology
3. To employ bionanomaterials for analysis and sensing techniques
4. To comprehend the current applications of nanobiotechnology and its scope.
5. To understand ethical, legal and social implications of nanobiotechnology

SYLLABUS

UNIT-I **(8 Hours)**

A brief history, definition of nanotechnology, nanobiotechnology v/s bionanotechnology, bottom-Up versus top- down approaches; Methods of synthesis of nanoparticles –physical (bead mill, laser ablation) chemical (sol-gel , precipitation, chemical reduction) and biological (use of microbes, enzymes, plant materials), parameters affecting, nanoparticle growth, shape, size and structure. Structure –property relationships in materials, nanolithography-UV and electron beam.

UNIT-II **(8 Hours)**

Nanomaterials and their characterization -: Fullerenes – buckyballs, carbon nanotubes, dendrimers, nanoparticles, nanocomposites, nanoshells, quantum dot, principle, instrumentation and applications of UV, FTIR, Raman shift, surface plamon resonance (SPR),SEM, TEM, atomic force microscopy

UNIT-III **(8 Hours)**

Nanomolecular diagnostics-: Rationale of nanotechnology for molecular diagnostics, bio- functionalization methods, nanoparticles like gold,quantum dots, and magnetic nanoparticles in diagnostics,. Nanobiosensors Nanopore technology: cantilever, carbon nanotube, nanowires. Pathogen detection by magnetic nanoparticle-based techniques

UNIT-IV **(8 Hours)**

Nanobiotechnological applications in environment and food – detection and mitigation of pollutants and adultrants. **Biomedical and life sciences applications**-: Introduction to nanomedicine, nanocapsules, nanorobots, nanopharmacology. Use of micro needles and nanoparticles for local highly controlled drug delivery. Nanotechnology products and applications in ocular, oncology, neurology and cardiology. biomolecularnanomotors (ATP synthase complex and flagella).

UNIT-V **(8 Hours)**

Ethics, safety and regulatory aspects-: Introduction, ethical, legal and social implications of nano medicine and Nano-bio-products, safety concerns – health risks, and challenges, assessment of the toxic effects of nanoparticles based on in – vitro & in- vivo experiments, case studies. guidelines and regulatory aspects and evaluation of nano pharmaceuticals in India, Europe and USA, challenges and risks associated with markets for nano medicine.

TEXT /REFERENCE BOOKS:

1. Niemeyer, C.M and Mirkin CA “Nanobiotechnology: concepts, application and perspectives” Wiley-VCH, 2004.
2. Rosenthal, Sandra J and Wright, David W, “Nanobiotechnology protocols, Humana press, 2005.
3. Stephen Lee and Lynn M Savage, “Biological molecules in Nanotechnology”, International Business Communications, Inc, 1998.

OPEN ELECTIVE

NANOTECHNOLOGY & NANOSCIENCE (BT0-001)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES:

1. To understand the fundamentals of Nanotechnology.
2. To learn general introduction about different classes of nanomaterials.
3. To impart basic knowledge on various synthesis and characterization techniques involved in Nanotechnology.
4. To be familiarize with nanotechnology potentialities in different field of life like electronics, medical field etc.

COURSE OUTCOMES

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

1. Develop new systems and technologies by using nanobotechnology for making human life healthier and prosperous.
2. Synthesize and characterize different new nanomaterials and nanoparticles for potential human applications and for betterment of human society.
3. Describe basic science behind the properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.

SYLLABUS

UNIT-I **(8 Hours)**

Basics and Scale of Nanotechnology: Introduction–Scientific revolutions–Time and length scale in structures–Definition of a nanosystem–Dimensionality and size dependent phenomena–Surface to volume ratio-Fraction of surface atoms–Surface energy and surface stress-surface defects-Properties at nanoscale (optical, mechanical,electronic,and magnetic).

UNIT-II **(8 Hours)**

Different Classes of Nano Materials: Classification based on dimensionality-Quantum Dots,Wells and Wires-Carbon- based nano materials (buckyballs, nanotubes, graphene)–Metal based nanomaterials (nanogold, nanosilver and metal oxides)-Nanocomposites-Nanopolymers–Nanoglasses–Nano ceramics-Biological nanomaterials.

UNIT-III **(8 Hours)**

Synthesis of Nanomaterials: Physical-chemical and mechanical methods of preparation –Top down approach-Chemical Vapor Deposition-High-energy balling-Nanostructure through Lithography.Bottom up approach: Colloidal precipitation –Sol-Gel process–Chemical precipitation –Biosynthesis –Electrospining method.

UNIT-IV **(8 Hours)**

Characterization of Nanostructures: Characterization of electrical-optical-mechanical and magnetic propertiesofnanomaterials. Electrical conductivity and permittivity-magnetic permeability-Structural characterization: X-ray diffraction-Electron microscopy-FTIR-XPS. Surface characterization: scanning electron microscopy-atomic force microscopy. Characterization of porous structures.Characterization of quasi-static and dynamic elastic properties.Mechanical testing.

UNIT-V **(8 Hours)**

Applications :Potential uses of nanomaterials in electronics, robotics, computers, sensors, sports equipment, mobile electronic devices, vehicles and transportation–Medical applications of nanomaterials, Nanocomposite materials for therapy and food packaging-Functional graphene-carbon nanotube and polymer composite applications in defence and aerospace. Nanomaterials for solar Cells-Nanoscale catalysts for energy and automobile industries. Rechargeable batteries based on nanomaterials-Nanomaterials for electrodes and wearable electronics-Nano based coating and paints, Nanomedicine and Nanobiotechnology–Nanotoxicology challenges.

NANOTECHNOLOGY & NANOSCIENCE (BTT-001)

L:T:P::3:0:0 **Credits-3**

TEXT /REFERENCE BOOKS:

1. PradeepT., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology",Academic Press, 20

Open -Elective

ENVIRONMENTAL SUSTAINABILITY AND RENEWABLE ENERGY (BTT-002)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVE:

1. To learn about basic concepts of Environmental Sustainability and renewable energy.
2. To impart knowledge about different type of renewable energy.
3. To know efficient and profitable use of renewable energy resources.

COURSE OUTCOMES

1. Articulate the fundamental principles, terminology and key issues related to the major onshore and offshore renewable energy technologies.
2. Critically compare the challenges for the development and operation of the major technologies, including government regulation and policy.
3. Identify gaps in the knowledge and discuss potential opportunities for further development, including technology and economic potential

SYLLABUS

UNIT-I **(8 Hours)**

Basic concepts of sustainable and renewable energy, Sustainable development, 3R's of waste management, Environmental Impact Assessment (EIA), Steps for the EIA process, types of renewable energy resources, Technological basis of their uses and applications

UNIT-II **(8 Hours)**

Solar Energy: Introduction to Solar Energy, Solar Photovoltaic Technology, Applications of photovoltaic systems, Photovoltaic and concentrated Solar Power (CSP), Physics of solar cells-cell and module, Instruments for measurements of solar radiation, Principals and operation of different types of solar radiation collectors, Methods of solar power generation

UNIT-III **(8 Hours)**

Passive Solar Technology: Passive Solar Design, Passive Solar Heating, Passive Solar Cooling, Passive Solar Home Design, Sunrooms and Sunspaces, Energy Efficient Window Coverings, Landscaping for Energy-Efficient Homes

UNIT-IV **(8 Hours)**

Biomass Energy: Basics, Bioenergy Technologies: Biofuels, Biopower, Bioproducts, Biomass Resources, Benefits of Biomass, Biofuel conversion processes: Pyrolysis, Gasification, Hydrothermal liquefaction.

UNIT-V **(8 Hours)**

Hydropower, Benefits of hydropower, Geothermal Energy, Geothermal Applications Ocean Energy, Transportation: Electric Vehicle, Wind Energy, Wind Turbine

TEXT/REFERENCE BOOKS

1. John Andrews et al.2013, Energy Science: Principles, Technologies and Impacts. Oxford Universities Press.
2. Godfrey Boyle, 2012. Renewable Energy, Power for a sustainable future. Oxford Universities Press
3. Fang Lin You et al.2012.2012 Renewable Energy Systems, Advanced Conversion Technologies and Applications. CRC Press.

Open -Elective

BIOFUELS AND BIOENERGY (BTT-003)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. This course aims to provide different strategies to convert biomass to biofuels
2. To provide the review of the available and advanced technologies and how these could meet the growing demand for energy in the future
3. To assess environmental impacts and economy of biofuels

COURSE OUTCOMES

After completing this course the students will be able to:

1. Summaries the basic fundamental concepts of biofuel and bioenergy.
2. Evaluate clearly and concisely the benefits and problems relating to the production of biofuels from biomass.
3. Apply approaches in biofuels including Microbial fuel cell, Advanced power plant concepts (IGCC) and etc.
4. Calculate the energy generating potential of biomass as an energy source
5. Investigate the potential of biodiesel as an engine fuel.
6. Critically assess the economy of biorenewable resources and environmental impact of the bioeconomy.

SYLLABUS

UNIT-I **(8 Hours)**

Energy perspective: Current methods, Biomass possibilities. Fundamental concepts in understanding biofuel and bioenergy production: Mass Balances, Energy Balances, Thermodynamics, Organic compounds, Chemistry of plant materials resources.

UNIT-II **(8 Hours)**

Fossil versus renewable energy.Production of biorenewable resources**:** Herbaceous crops,Woody crops**,** Algae. Conversion of biomass into heat and power**:** Direct combustion**,** Thermal gasification**,** Anaerobic digestion. Processing of biomass into chemicals and fuels: Sugars, Alcohols, Biodiesel, Thermochemical conversion, Fischer Tropsch Fuels.

UNIT-III **(8 Hours)**

Combustion Engines, Turbines and FuelRatings.Microbial fuel cell, Advanced power plant concepts (IGCC, NGCC), Gas to liquid processes(GTL), Carbon dioxide capture and storage, Chemical Looping.

UNIT-IV **(8 Hours)**

Comparison of Bio-energy Sources, Biorefinery, Biofuels for Transportation, Vegetable Oils as Engine Fuels.Biodiesel as Engine Fuel:Engine Emissions from Biodiesel, Biodiesel production by using various microorganisms, algae and Transesterification process, methods of biodiesel production.

UNIT-V **(8 Hours)**

Environmental impact of the bioeconomy**:** Land use**,** Pollution**,** Climate change. Economics of biorenewable resources**:** Feedstock costs**,** Capital costs**,** Operating costs. Economics of biogas plants. Algae biofuels: versatility for the future of bioenergy.

TEXT /REFERENCE BOOKS:

1. C. M. Drapcho, N. P. Nhuan, T. Walker, Biofuel Engineering Process Technology, McGraw Hill 2008
2. D. M. Mousdale, Biofuels, CRC Press 2008
3. Carlson, R. 2007. Laying the foundations for a bio-economy.Systems and Synthetic Biology.
4. Gaskell, G. et al. 2011. The 2010 Eurobarometer on the life sciences.Nature Biotechnology. 29:113-114

Open -Elective

BIOMATERIALS (BTT-004)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. Strategies to modify and/or design materials that are biocompatible
2. Explain what biocompatibility is and how it affects biomaterial design
3. Understand material selection and structure-function relationships

COURSE OUTCOMES

After successfully completing this course, students will be able to:

1. Understand common use biomaterials as metals, ceramics and polymers and its chemical structure, properties and morphology
2. Understand and account for methods for the characterization and categorization of biomaterials;
3. Understand, identify and describe general methods for the assessment of biocompatibility of biomaterials
4. Understand the interaction between biomaterial and tissue for short term and long-term implantations and account for methods to characterize interactions between materials and tissue.
5. Identify and describe applications of biomaterials based on interactions between materials and tissue.

SYLLABUS

UNIT-I **(8 Hours)**

Classes of materials used in medicine, Metals, Ceramics, Synthetic polymers, Composites, Hydrogels, Bioresorbable and Biodegradable materials, Natural materials, Structure and properties relationships of biological materials.

UNIT-II **(8 Hours)**

Materials characterization - definition; importance and application, Principles and general methods of compositional and structural characterization, techniques of X-ray, electron and neutron diffraction, EDAX, Thermal methods - DTA, TGA, DSC, DMA, temperature dependent rheology.

UNIT-III **(8 Hours)**

Concept of biocompatibility, Structure and properties of biological cells & tissues, Cell-material interactions and foreign body response, Assessment of biocompatibility of biomaterials, In vitro biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation using ALP assay; Bio mnuneralisation using Osteocalcin assay), In vivo testing and histo-compatibility assessment, Geno-toxicity assessment (Physical damage to DNA by biomaterial eluates)

UNIT-IV **(8 Hours)**

Material Response: Material and Tissue interaction, biological environment and host response - Inflammation, Wound Healing and Foreign Body Response - Failure mechanisms; corrosion, fracture, degradation of Implanted Materials – Polymers, Metals, ceramics.

UNIT-V **(8 Hours)**

In-vitro Applications, in-vivo applications, Biomedical application: Cardiovascular, Dental implants, Orthopedic application, Skin, Ophthalmologic applications, Wound healing, Biomedical and Biosensor applications.

TEXT /REFERENCE BOOKS:

1. Wagner, William R., et al., eds. Biomaterials science: An introduction to materials in medicine. Academic Press, 2020.
2. B. D. Ratner, A. S. Hoffman, F. J. Schoen and J. E. Lemons, Biomaterials Science, Second Edition: Wiley Science (2004).
3. L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering (Woodhead Publishing in Materials (2002).
4. Temenoff J.S. and Mikos A.G., Biomaterials: The intersection of Biology and Materials Science, Pearson, (2009).

OPEN ELECTIVE

NANOTECHNOLOGY & NANOSCIENCE (BT0-001)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES:

5. To understand the fundamentals of Nanotechnology.
6. To learn general introduction about different classes of nanomaterials.
7. To impart basic knowledge on various synthesis and characterization techniques involved in Nanotechnology.
8. To be familiarize with nanotechnology potentialities in different field of life like electronics, medical field etc.

COURSE OUTCOMES

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

4. Develop new systems and technologies by using nanobotechnology for making human life healthier and prosperous.
5. Synthesize and characterize different new nanomaterials and nanoparticles for potential human applications and for betterment of human society.
6. Describe basic science behind the properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.

SYLLABUS

UNIT-I **(8 Hours)**

Basics and Scale of Nanotechnology: Introduction–Scientific revolutions–Time and length scale in structures–Definition of a nanosystem–Dimensionality and size dependent phenomena–Surface to volume ratio-Fraction of surface atoms–Surface energy and surface stress-surface defects-Properties at nanoscale (optical, mechanical,electronic,and magnetic).

UNIT-II **(8 Hours)**

Different Classes of Nano Materials: Classification based on dimensionality-Quantum Dots,Wells and Wires-Carbon- based nano materials (buckyballs, nanotubes, graphene)–Metal based nanomaterials (nanogold, nanosilver and metal oxides)-Nanocomposites-Nanopolymers–Nanoglasses–Nano ceramics-Biological nanomaterials.

UNIT-III **(8 Hours)**

Synthesis of Nanomaterials: Physical-chemical and mechanical methods of preparation –Top down approach-Chemical Vapor Deposition-High-energy balling-Nanostructure through Lithography.Bottom up approach: Colloidal precipitation –Sol-Gel process–Chemical precipitation –Biosynthesis –Electrospining method.

UNIT-IV **(8 Hours)**

Characterization of Nanostructures: Characterization of electrical-optical-mechanical and magnetic propertiesofnanomaterials. Electrical conductivity and permittivity-magnetic permeability-Structural characterization: X-ray diffraction-Electron microscopy-FTIR-XPS. Surface characterization: scanning electron microscopy-atomic force microscopy. Characterization of porous structures.Characterization of quasi-static and dynamic elastic properties.Mechanical testing.

UNIT-V **(8 Hours)**

Applications :Potential uses of nanomaterials in electronics, robotics, computers, sensors, sports equipment, mobile electronic devices, vehicles and transportation–Medical applications of nanomaterials, Nanocomposite materials for therapy and food packaging-Functional graphene-carbon nanotube and polymer composite applications in defence and aerospace. Nanomaterials for solar Cells-Nanoscale catalysts for energy and automobile industries. Rechargeable batteries based on nanomaterials-Nanomaterials for electrodes and wearable electronics-Nano based coating and paints, Nanomedicine and Nanobiotechnology–Nanotoxicology challenges.

NANOTECHNOLOGY & NANOSCIENCE (BTO-001)

L:T:P::3:0:0 **Credits-3**

TEXT /REFERENCE BOOKS:

1. Pradeep T., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology",Academic Press, 20

Open -Elective

ENVIRONMENTAL SUSTAINABILITY AND RENEWABLE ENERGY (BTO-002)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVE:

1. To learn about basic concepts of Environmental Sustainability and renewable energy.
2. To impart knowledge about different type of renewable energy.
3. To know efficient and profitable use of renewable energy resources.

COURSE OUTCOMES

1. Articulate the fundamental principles, terminology and key issues related to the major onshore and offshore renewable energy technologies.
2. Critically compare the challenges for the development and operation of the major technologies, including government regulation and policy.
3. Identify gaps in the knowledge and discuss potential opportunities for further development, including technology and economic potential

SYLLABUS

UNIT-I **(8 Hours)**

Basic concepts of sustainable and renewable energy, Sustainable development, 3R's of waste management, Environmental Impact Assessment (EIA), Steps for the EIA process, types of renewable energy resources, Technological basis of their uses and applications

UNIT-II **(8 Hours)**

Solar Energy: Introduction to Solar Energy, Solar Photovoltaic Technology, Applications of photovoltaic systems, Photovoltaic and concentrated Solar Power (CSP), Physics of solar cells-cell and module, Instruments for measurements of solar radiation, Principals and operation of different types of solar radiation collectors, Methods of solar power generation

UNIT-III **(8 Hours)**

Passive Solar Technology: Passive Solar Design, Passive Solar Heating, Passive Solar Cooling, Passive Solar Home Design, Sunrooms and Sunspaces, Energy Efficient Window Coverings, Landscaping for Energy-Efficient Homes

UNIT-IV **(8 Hours)**

Biomass Energy: Basics, Bioenergy Technologies: Biofuels, Biopower, Bioproducts, Biomass Resources, Benefits of Biomass, Biofuel conversion processes: Pyrolysis, Gasification, Hydrothermal liquefaction.

UNIT-V **(8 Hours)**

Hydropower, Benefits of hydropower, Geothermal Energy, Geothermal Applications Ocean Energy, Transportation: Electric Vehicle, Wind Energy, Wind Turbine

TEXT/REFERENCE BOOKS

1. John Andrews et al.2013, Energy Science: Principles, Technologies and Impacts. Oxford Universities Press.
2. Godfrey Boyle, 2012. Renewable Energy, Power for a sustainable future. Oxford Universities Press
3. Fang Lin You et al.2012.2012 Renewable Energy Systems, Advanced Conversion Technologies and Applications. CRC Press.

Open -Elective

BIOFUELS AND BIOENERGY (BTO-003)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. This course aims to provide different strategies to convert biomass to biofuels
2. To provide the review of the available and advanced technologies and how these could meet the growing demand for energy in the future
3. To assess environmental impacts and economy of biofuels

COURSE OUTCOMES

After completing this course, the students will be able to:

1. Summaries the basic fundamental concepts of biofuel and bioenergy.
2. Evaluate clearly and concisely the benefits and problems relating to the production of biofuels from biomass.
3. Apply approaches in biofuels including Microbial fuel cell, Advanced power plant concepts (IGCC) and etc.
4. Calculate the energy generating potential of biomass as an energy source
5. Investigate the potential of biodiesel as an engine fuel.
6. Critically assess the economy of biorenewable resources and environmental impact of the bioeconomy.

SYLLABUS

UNIT-I **(8 Hours)**

Energy perspective: Current methods, Biomass possibilities. Fundamental concepts in understanding biofuel and bioenergy production: Mass Balances, Energy Balances, Thermodynamics, Organic compounds, Chemistry of plant materials resources.

UNIT-II **(8 Hours)**

Fossil versus renewable energy.Production of biorenewable resources**:** Herbaceous crops,Woody crops**,** Algae. Conversion of biomass into heat and power**:** Direct combustion**,** Thermal gasification**,** Anaerobic digestion. Processing of biomass into chemicals and fuels: Sugars, Alcohols, Biodiesel, Thermochemical conversion, Fischer Tropsch Fuels.

UNIT-III **(8 Hours)**

Combustion Engines, Turbines and Fuel Ratings. Microbial fuel cell, Advanced power plant concepts (IGCC, NGCC), Gas to liquid processes (GTL), Carbon dioxide capture and storage, Chemical Looping.

UNIT-IV **(8 Hours)**

Comparison of Bio-energy Sources, Biorefinery, Biofuels for Transportation, Vegetable Oils as Engine Fuels.Biodiesel as Engine Fuel: Engine Emissions from Biodiesel, Biodiesel production by using various microorganisms, algae and Transesterification process, methods of biodiesel production.

UNIT-V **(8 Hours)**

Environmental impact of the bioeconomy**:** Land use**,** Pollution**,** Climate change. Economics of biorenewable resources**:** Feedstock costs**,** Capital costs**,** Operating costs. Economics of biogas plants. Algae biofuels: versatility for the future of bioenergy.

TEXT /REFERENCE BOOKS:

1. C. M. Drapcho, N. P. Nhuan, T. Walker, Biofuel Engineering Process Technology, McGraw Hill 2008
2. D. M. Mousdale, Biofuels, CRC Press 2008
3. Carlson, R. 2007. Laying the foundations for a bio-economy.Systems and Synthetic Biology.
4. Gaskell, G. et al. 2011. The 2010 Eurobarometer on the life sciences.Nature Biotechnology. 29:113-114

Open -Elective

BIOMATERIALS (BTO-004)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. Strategies to modify and/or design materials that are biocompatible
2. Explain what biocompatibility is and how it affects biomaterial design
3. Understand material selection and structure-function relationships

COURSE OUTCOMES

After successfully completing this course, students will be able to:

1. Understand common use biomaterials as metals, ceramics and polymers and its chemical structure, properties and morphology
2. Understand and account for methods for the characterization and categorization of biomaterials;
3. Understand, identify and describe general methods for the assessment of biocompatibility of biomaterials
4. Understand the interaction between biomaterial and tissue for short term and long-term implantations and account for methods to characterize interactions between materials and tissue.
5. Identify and describe applications of biomaterials based on interactions between materials and tissue.

SYLLABUS

UNIT-I **(8 Hours)**

Classes of materials used in medicine, Metals, Ceramics, Synthetic polymers, Composites, Hydrogels, Bioresorbable and Biodegradable materials, Natural materials, Structure and properties relationships of biological materials.

UNIT-II **(8 Hours)**

Materials characterization - definition ; importance and application, Principles and general methods of compositional and structural characterization, techniques of X-ray, electron and neutron diffraction, EDAX, Thermal methods - DTA, TGA, DSC, DMA, temperature dependent rheology.

UNIT-III **(8 Hours)**

Concept of biocompatibility, Structure and properties of biological cells & tissues, Cell-material interactions and foreign body response, Assessment of biocompatibility of biomaterials, In vitro biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation using ALP assay; Bio mnuneralisation using Osteocalcin assay), In vivo testing and histo-compatibility assessment, Geno-toxicity assessment (Physical damage to DNA by biomaterial eluates)

UNIT-IV **(8 Hours)**

Material Response: Material and Tissue interaction, biological environment and host response - Inflammation, Wound Healing and Foreign Body Response - Failure mechanisms; corrosion, fracture, degradation of Implanted Materials – Polymers, Metals, ceramics.

UNIT-V **(8 Hours)**

In-vitro Applications, in-vivo applications, Biomedical application: Cardiovascular, Dental implants, Orthopedic application, Skin, Ophthalmologic applications, Wound healing, Biomedical and Biosensor applications.

TEXT /REFERENCE BOOKS:

1. Wagner, William R., et al., eds. Biomaterials science: An introduction to materials in medicine. Academic Press, 2020.
2. B. D. Ratner, A. S. Hoffman, F. J. Schoen and J. E. Lemons, Biomaterials Science, Second Edition: Wiley Science (2004).
3. L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering (Woodhead Publishing in Materials (2002).
4. Temenoff J.S. and Mikos A.G., Biomaterials: The intersection of Biology and Materials Science, Pearson, (2009).

Open -Elective

BIOINFORMATICS (BTO-005)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To acquire knowledge how bioinformatics data is stored and organized
2. To explain how to locate and extract data from key bioinformatics databases and resources
3. To describe the methods of sequencing
4. To describe various algorithms for sequence alignment and protein modelling.
5. To explain the concept and methods of gene prediction.

COURSE OUTCOMES

After successfully completing this course, students will be able to

1. On the completion of this course students shall have knowledge to identify, adapt and develop in silicon models appropriate to the specific study of different biological projects.
2. The students will be familiar with the use of bioinformatics software, tools in their area of research.

UNIT I

Introduction to Bioinformatics, Goals, Scope, Applications in Biological Science, Medicine and Limitations, Databases, types of biological databases (primary, Secondary and specialized) Nucleotide sequence databases (EMBL, Gene Bank, DDBJ), protein sequence database (Swiss prot, PIR), Protein Structure Database (PDB,SCOP,CATH), other databases Pfam, EST, TFB sites, PROSITE,KEGG, Data Retrieval with Entrez,SRS, DBGET.

UNIT II

Principle of DNA sequencing (Chemical chain termination, dideoxy chain termination method, automated sequencer), Protein sequencing (Edmand degradation method), sequence submission to various databases.

UNIT III

Sequence alignment Pair wise and multiple sequence alignment, dynamic programming, Scoring matrix, gap penalty, Sequence alignment algorithm (FAST, BLAST, Needleman and Wunsch, Smith Waterman), Amino acid substitution matrices (PAM BLOSUM).

UNIT IV

Protein structure prediction (Chou Fasman method) Secondary and tertiary structures, Homology Modelling Template recognition and initial alignment, Alignment correction, Backbone generation, Loop modelling, Side-chain modelling, Model optimization, Model validation, Threading , ab initio method, Protein-protein interaction ,Protein-ligand interaction, Protein-DNA interaction, Prediction of binding cavities.

UNIT V

Application of bioinformatics in High dimensional data analysis like Microarray etc, File format converter tool (BABEL, Read Seq), Drug designing/discovery.

TEXT REFERENCE BOOKS

1. Bioinformatics Principles and applications (1 st edition) by Ghosh and Mallick, Oxford university press,(2015).
2. Bioinformatics A Practical Guide to the Analysis of Genes and Proteins (Methods of Biochemical Analysis),(2 nd edition) by Andreas D Boxevanis, Wiley–Blackwell, (2001).
3. Bioinformatics Volume I Data, Sequence Analysis, and Evolution (Methods in Molecular Biology),(3 rd edition) by Jonathan M. Keith,Humana press, (2017)