COURSE STRUCTURE

B.TECH.

BIOTECHNOLOGY

Under

Choice Based Credit System(CBCS)

(w.e.f. Session2025-26)

Credits Distributions

Sr.No.	Category	No. Of Credits
1	Humanities And Social Sciences (HS)	19
2	Basic Sciences (BS)	19
3	Engineering Sciences (ES)	16
4	Professional Core (PC)	59
5	Professional Elective (PE)	18
6	Open Elective (OE)	16
7	Project Work (PW)	18
8	Mandatory Non-Credit Courses (MNG)(4courses)	4U
Total		**165**

First Semester

S. NO.	CAT	CODE	SUBJECT	TEACHINGSCHEME				CREDITS
				L	T	P	J	
1.	BS	BMAS0130/ BBTS0001	Elementary Mathematics-I/ Introduction to Biology	3	1	0	0	4
2.	BS	BCHS 2101	Engineering Chemistry	2	1	0	0	3
3.	PC	New Code	Bioelectronics	4	0	0	0	4
4.	ES	New Code	Engineering Graphics and Design	2	0	0	0	2
5.	ES	BCSG1001	Python programming	3	0	0	0	3
6	BS	BCHS0801	Engineering Chemistry Lab	0	0	2	0	1
8	HS	BELH0811	English Communication Skills-1	0	0	4	0	2
9	ES	BCSG1800	Python programming Lab	0	0	2	0	1
10	ES	New Code	Engineering workshop	0	0	2	**0**	1
11	ES	New Code	Engineering Graphics & Design Lab	0	0	2	**0**	1
			Field Project -I	0	0	0	**4**	1
			TOTAL	**14**	**2**	**10**	**0**	**23**

Second Semester

S. NO.	CAT	CODE	SUBJECT	TEACHING SCHEME				CREDITS
				L	T	P	J	
1.	BS	NEWCODE	Biostatistics	3	1	0	0	4
2.	BS	BPHS 0100	Physics for Engineers	2	1	0	0	3
4.	ES	BCSO0001	Data Structure and Application	3	0	0	0	3
	PC	New Code	Introduction to Biomolecules and Bioenergetics	3	0	0	**0**	3
5.	PC	New Code	Cell Biology & Basic Genetics	3	0	0	0	3
6	BS	BCHS0801	Engineering Physics Lab	0	0	2	0	1
7	ES	BCSO0070	Data Structure and Application Lab	0	0	2	0	1
	PC	New Code	Cell Biology & Basic Genetics Lab	0	0	2	0	1
9	HS	BELH1801	English Language Lab-II	0	0	4	0	2
11.	PW	APFJ0001	Field Project-II	0	0	0	4	1
			TOTAL	**13**	**2**	**12**	**4**	**22**

Professional Core

S. NO.	CODE	SUBJECT	TEACHINGSCHEME				CREDITS
			L	T	P	J	
1.	New Code	Cell Biology and Basic Genetics	3	0	0	0	3
2.	New Code	Biochemistry	3	0	0	0	3
3.	New Code	Introduction to Biomolecule and Bioenergetics	3	0	0	0	3
3.	BBTC0005	Food Technology	3	0	0	0	3
4.	New Code	Bioanalytical techniques-1	3	0	0	0	3
5.	BBTC0007	Microbiology	3	0	0	0	3
6.	NEW CODE	Molecular Biology	3	0	0	0	3
7.	New Code	Recombinant DNA Technology	3	0	0	0	3
8.	BBTC	Immunology	3	0	0	0	3
9.	BBTC1011	Bioprocess Engineering	3	0	0	0	3
10.	New Code	Bioanalytical techniques-II	3	0	0	0	3
11.	BBTC0013	Animal Biotechnology	3	0	0	0	3
12.	BBTC0014	Plant Biotechnology	3	0	0	0	3
13.		Proteomics and Genomics	3	0	0	0	3
14.	New Code	Introduction to Bioinformatics	3	0	0	0	3
15.	New Code	Cell Biology & Basic Genetics Lab	0	0	2	0	1
16,	New Code	Biochemistry Lab	0	0	2	0	1
17.	New Code	Bioanalytical techniques -II Lab	0	0	2	0	1
18.	New Code	Enzyme Engineering & Technology	3	0	0	0	3
19.	New Code	Microbiology Lab	0	0	2	0	1
20.	New Code	Immunology Lab	0	0	2	0	1
		Proteomics and Genomics lab		0	2	0	1
21.	BBTC0805	RDT and Molecular Biology Lab	0	0	2	0	1
22.	BBTC0806	Animal Biotechnology Lab	0	0	2	0	1
23.	BBTC0807	Plant Biotechnology Lab	0	0	2	0	1
24.	New Code	Bioinformatics Lab	0	0	2	0	1
25.	New Code	Food and Enzyme Engineering & Technology lab	0	0	2	0	1
Total			**42**	**1**	**18**	**0**	**59**

Humanities and Social Sciences

S. NO.	CODE	SUBJECT	TEACHINGSCHEME				CREDITS
			L	T	P	J	
1.	MBAH0005	Industrial Management	3	0	0	0	3
2.	BELH0006	Ethics and Value	2	0	0	0	2
3.	BELH0081	English communication skill –I	2	0	0	0	2
4.	BELH0082	English communication skill –II	0	0	2	0	2
5.	BTDH0301	Soft Skills–I	0	0	2	0	1
6.	BTDH0302	Soft Skills–II	0	0	2	0	1
7.	BTDH0303	Soft Skills–III	0	0	8	0	4
8.	BTDH0304	Soft Skills–IV	0	0	8	0	4
TOTAL			**07**	**0**	**22**	**0**	**19**

Basic Sciences

S. NO.	CODE	SUBJECT	TEACHINGSCHEME				CREDITS
			L	T	P	J	
1.	DHM100/BBTC0001	Applied Mathematics–I/ Introduction to Biology	3	1	0	0	4
2.	BMAS0501	Biostatistics	3	1	0	0	4
3.	BCHS0101	Engineering Chemistry	2	1	0	0	3
4.	BPHS0001	Engineering Physics	2	1	0	0	3
5.	BCHS0201	Environmental Studies	3	0	0	0	3
6.	BCHS0801	Engineering Chemistry Lab	0	0	2	0	1
7.	BPHS0801	Engineering Physics Lab	0	0	2	0	1
TOTAL			**17**	**5**	**4**	**0**	**19**

Engineering Sciences

S. NO.	CODE	SUBJECT	TEACHINGSCHEME				CREDITS	PRE-REQUISITES
			L	T	P	J		
1.		Bioelectronics	3	0	0	0	4	
3.		Python programming	3	0	0	0	3	
4.		Engineering Graphics & Design	2	0		0	2	
		Data Structure and application	3	0	0	0	3	
5.		Python programming Lab-I	0	0	2	0	1	
6.		Workshop/Manufacturing Practices		0	2	0	1	
7.		Data Structure and application Lab	0	0	2	0	1	
8.		Engineering Graphics & Design lab	0	0	2	0	1	
Total			**11**	**0**	**10**	**0**	**16**	

Projects

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J			
		Field Project I				4	1		
		Field Project II				4	1		
1.		Mini Project I (after 4th Sem)	0	0	0	8	2	0	
		Mini Project II (After 6th Sem)	0	0	0	8	2	0	
5.		Major Project (5-6 Months)	0	0	0	0	12	0	
Total							**18**	**0**	

Professional Elective

S. NO.	CODE	SUBJECT	TEACHINGS CHEME				CREDITS	CONTACTS HR/WK
			L	T	P	J		
1.		Fermentation Technology	3	0	0	0	3	3
3.		Algorithm for Bioinformatics	3	0	0	0	3	3
		IPR and Bioethics	2	0	0	0	2	2
4.		Computer Added Drug Designing	3	0	0	0	3	3
5.		Virology and Cancer Biology	3	0	0	0	3	3
6.		Molecular Diagnostics	3	0	0	0	3	3
7.		Nano-biotechnology	0	0	0	0	3	2
		Nano-biotechnology Lab	0	0	2	0	1	2
8.		Fermentation technology and Bioprocessing Lab.	0	0	2	0	1	2
9.		Molecular Diagnostics and Therapeutics Lab	0	0	2	0	1	2
10.		Algorithm for Bioinformatics lab.	0	0	2	0	1	2

Open Elective (Offer to other Departments)

For interdisciplinary knowledge, 16 Credits of Open Electives subjects shall be taken by the students of B.Tech.(Biotech.). These electives shall be offered by other departments of University.

However, following are the detail of Open Elective subjects to be offered from Bio-Technology department

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTSHR /WK	PRE-REQUISITES
			L	T	P	J			
THEORY									
1.	BBTO0003	Nonmaterial &Nanotechnology	3	2	0	0	4	5	
2.	BBTO0002	Bioinformatics	3	2	0	0	4	5	

Mandatory Non Graded Course

S. NO.	CODE	SUBJECT	TEACHINGSCHEME				CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J			
THEORY									
2.	BCSM0001	Introduction to Cyber Security	2	0	0	0	0	2	
3.	BCHM0101	Disaster Management	2	0	0	0	0	2	
4.	MBAM0001	Basic Course in Entrepreneurship	2	0	0	0	0	2	
5.	MBAM0002	Leadership And Organizational Behavior	2	0	0	0	0	2	
6.	BMEM0002	Waste to Energy	2	0	0	0	0	2	

Semester -III

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1.		Bioanalytical techniques -I	2	0	0	2	2
2.		Molecular Biology	3	0	0	3	3
3.		Microbiology	3	0	0	3	3
4.		NPTEL				4	0
6.		Bioinformatics	3	0	0	3	3
		Enzyme Engineering & Technology	2	0	0	2	2
PRACTICALS							
7.		Microbiology Lab	0	0	2	1	2
8.		Bioinformatics Lab.	0	0	2	1	2
9.		English for Professional Purpose - I	2	2	0	2	2
10.		Soft Skills – I	0	0	2	1	2
11.	MBAM0002	Leadership And Organizational Behavior (MNG)	2	0	0	0	0
		TOTAL	**20**	**2**	**10**	**22**	**21**

Semester -IV

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1.		Biochemistry	3	0	0	3	3
2.		Immunology	3	0	0	3	3
3.		Recombinant DNA Technology	3	0	0	3	3
		Fermentation Technology	3	0	0	3	3
4.		OPEN Elective /NPTEL	4	0	0	4	0
PRACTICALS							
7.		RDT and Molecular Biology Lab	0	0	2	1	2
		Biochemistry Lab.	0	0	2	1	2
		Bioprocess and Fermentation Technology Lab.	0	0	2	1	2
		Immunology Lab	0	0	2	1	2
9.		English for Professional Purpose - II	2	2	0	2	4
10.		Soft Skills – II	0	0	2	1	2
11.		Basic Courses in Entrepreneurship **(MNG)**	2				2
		TOTAL	**18**	**2**	**8**	**23**	**26**

Semester -V

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1.		Food Technology	3	0	0	3	3
2.		Plant Biotechnology	3	0	0	3	3
3.		Open Elective /NPTEL				4	0
4.		Bioprocess Engineering	3	0	0	3	3
PRACTICALS							
5.		Plant Biotechnology Lab	0	0	2	1	2
6.		Food and Enzyme Engineering & Technology Lab	0	0	2	1	2
7.		Soft Skills – III	0	0	8	4	4
8.		Ethics & Values	0	0	2	1	2
9.		Mini Project – I	0	0	0	2	0
10.		Introduction to Cyber Security (MNG)	2	0	0	0	2
		TOTAL	**17**	**0**	**14**	**22**	**21**

Semester -VI

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
		Bioanalytical Techniques II	3	0	0	3	3
		Animal Biotechnology	3	0	0	3	3
5.		Algorithms for Bioinformatics	3	0	0	3	3
		NPTEL				4	0
PRACTICALS							
7.		Animal Biotechnology Lab	0	0	2	1	2
		Bioanalytical Techniques II Lab	0	0	2	1	2
9.		Soft Skills – IV	0	0	8	4	4
		Algorithms for Bioinformatics Lab.	0	0	2	1	2
10.		Industrial Management	3	0	0	3	3
		Mini Project – II	0	0	0	2	0
11.		Disaster Management (MNG)	2	0	0	0	2
		TOTAL	**20**	**1**	**14**	**25**	**22**

Semester -VII

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			L	T	P	
2.		Computer added Drug Designing	3	0	0	3
4.		Bioethics and IPR	2	0	0	2
5.		Proteomics & Genomics	3	0	0	3
		Environmental Studies	3	0	0	3
7.		Computer added Drug Designing Lab.	0	0	2	1
8.		Proteomics & Genomics Lab.	0	0	2	1
		TOTAL	**11**	**0**	**4**	**12**

Semester -VIII

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			L	T	P	
2.		Project Training (5-6 Months)	0	0	0	12

CELL BIOLOGY AND BASIC GENETICS

Course Objectives:

- To gain basic understanding of cellular processes, pathways and cytoskeletal organization, concepts of cell signaling.
- To gain an understanding of classical genetics and apply the same to disorders.

Credits:03 **L-T-P-J:3-1-0-0**

Module No.	Contents	Teaching Hours (Approx.)
I	**CYTOLOGY AND CYTOSKELETON** Prokaryotic and eukaryotic cell, Cell Architecture, physio-chemical nature of plasma membrane and functions of cell organelle; nucleus, mitochondria, chloroplast, ribosomes, peroxisomes, Golgi bodies and endoplasmic reticulum. Cytosketal elements, Microtubules: structure & functions, shaping of the cells and mechanical support. Microfilaments: structure & functions. Structure of intermediate filaments. Cytoplasmic micro trabecular system (lattice). Covalent modifications of cytosmear proteins. Cytoskeletal architecture. **CELL CYCLE AND CELL SIGNALING:** Cell cycle studies; mitosis and meiosis. Cell Birth, lineage and death, Cellular senescence and ageing, Hayflick phenomenon, Senescence in ageing and age-related disease, Apoptosis and Necrosis, Cancer Cell Biology, Asymmetrical cell division, patterns of stem cell division. Signaling molecules and cell surface, receptors; intracellular signal transduction; G protein coupled receptors; plant growth factors and hormones, Eukaryotic and Prokaryotic cell to cell signaling, endocrine signaling, quorum sensing and intercellular signaling, Signal peptides, biofilm formation. **MEMBRANE TRANSPORT:** Membrane transport, passive and active transport; transport into prokaryotic cells; Endomembrane System: Golgi, Lysosomes Vesicular Traffic, Secretion, and Endocytosis, exocytosis; entry of viruses and toxins into cells Membrane trafficking: Translocation of secretory proteins across the ER membrane; protein modifications, folding and quality control in the ER; export and sorting of proteins to mitochondria, chloroplast and peroxisomes.	20

II	Nature of genetic material, Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower color in sweet peas, Epistasis- Inhibitory and colored genes in fowls, simple problems. Identification of genetic material, classical experiments- Hershey & Chase, Avery, McLeod etc. Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance molecular diseases, hemoglobinopathies. Disorders of coagulation, Colour blindness, hemophilia, Non-disjunction as a proof of chromosomal theory of inheritance, Linkage maps, crossing over. Chromosomal maps, interference coincidence. **POPULATION GENETICS:** Introduction, Gene frequency, and equilibrium estimation, changes in gene frequency, inbreeding and heterosis, genetic structure of population, speciation and evolution, prospects for the control of human evolution. Spontaneous and induced mutations, Eugenics. Pedigree analysis	20

Learning Outcomes:

At the end of the course, the student will be able to:
1. Co-relate cellular structure-function relationship in the context of cell growth and death.
2. Apply the concepts of cell signalling to biofilm formation.
3. Apply the principles of Mendelian Genetics to understand gene interactions, multiple alleles and sexlinked inheritance.
4. Apply principles of Chromosome structure and gene frequencies in the context of inherited disorders and population genetics.

Text Books:

- The Cell – A Molecular Approach, Cooper & Hausman, ASM Press, 2004.

Reference Books:

- Cell and molecular biology, EDPDe Robertis, EMF De Robertis, Lea &. Febiger Intl. ed.1991.
- Molecular Biology of the Cell, B. Alberts, et al., Garland Science, 4th ed. 2002.
- Molecular Cell Biology Hardcover ,James E. Darnell, Harvey Lodish, David Baltimore,1999

BBTC : INTRODUCTION TO BIOMOLECULES & BIOENERGETICS

OBJECTIVES: To teach students about important biomolecules essential to life processes.

Credits: 03 **Semester II** **L–T–P: 3–0–0**

Module No.	Content	Teaching Hours
I	**Basic aspects of the chemistry of life:** bonding properties of carbon, asymmetry of carbon compounds, basic concept of pH, pKa, buffers, various bonds stabilizing biomolecules (peptide, glycosidic, ester, phosphodiester, disulfide, ionic, hydrogen, hydrophobic, vanderwall's force), water as a solvent of life **Bioenergitcs:** I and II laws of thermodynamics, high energy phosphate compounds (ATP, creatine phosphate, thioesters), oxidative phosphorylation (chemiosmotic hypothesis, ATP synthase, P/O ratio, uncoupling), photophosphorylation **Carbohydrates:** chemical structures, classification, physiochemical properties and importance in biological cells **Amino acids:** chemical structures, classification, physiochemical properties, zwitterions nature, glucogenic and ketogenic amino acids	21
II	**Proteins:** classification based on source, shape, composition and function, structural organization of proteins (primary, secondary, tertiary and quaternary structures), physiochemical properties **Enzymes:** nomenclature and classification, characteristics of Enzymes, mode of Enzyme action (lock and key hypothesis, induced fit hypothesis),Enzyme kinetics, derivation of Michaelis- Menten equation **Lipids:** chemical structures, classification, physiochemical properties and functions **Nucleic acids:** structures of nitrogenous bases (adenine, guanine, thymine, cytosine and uracil), nucleotides and nucleosides, DNA secondary structure **Vitamins:** classification and functions	21

Text Book:

- Instant notes on Biochemistry by Holmes

Reference Books:

- A Text Book Of Biophysics, Author: Dr.R.N.Roy, Pub: New Central Book Agency (P) Ltd
- Principles of Biochemistry and Biophysics, Author: Dr.B.S.Chauhan, Pub: University science
- Essentials of Biophysics, Author: Narayana P, Pub: New Age Int, New Delhi
- Principles of Biochemistry, Author: AlbertL. Lehninger, Pub: CBS
- Biochemistry, Author: Lubert Stryer, Pub: Freeman International Edition
- Fundamentals of Biochemistry, Author: J.L.Jain, Pub: S. Chand and Company
- Biochemistry, Author: Keshav Trehan, Pub: Wiley Eastern
- Principles of Biochemistry, Author: Jeffory Zubey

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To understand basic fundamentals aspect of chemistry of life, which will help students to know about concept of Biochemistry.

CO2- To understand the concept of Bioenergetics which will help students to solve problem based on Biothermodynamics principles.

CO3- To know the structure, chemical and functional aspects of carbohydrates and amino acids..

CO4- To understand basic concept of proteins and enzymes in order to study the concept of protein metabolism.

CO5- To study structure, chemical and functional aspects of Nucleic acids and Vitamins.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO4, PO5 /PSO2, PSO3
CO2	PO2, PO4, PO6 /PSO1, PSO3
CO3	PO1, PO3, PO4 /PSO2, PSO3
CO4	PO1, PO3, PO5 /PSO1, PSO3
CO5	PO1, PO4, PO5 /PSO2, PSO3

BBTC : BIOCHEMISTRY

OBJECTIVES: To consolidate the student's training in Chemistry, Biology and other disciplines, as well as integrates the two to enhance a better understanding of biochemical principles.

Credits: 03 **Semester IV** **L–T–P: 3–0–0**

Module No.	Content	Teaching Hours
I	**Carbohydrate metabolism:** Embden-Meyerhof pathway , regulation of glycolysis, fermentation, anaerobic fate of pyruvate, pentose phosphate pathway, citric acid cycle, regulation of citric acid cycle, gluconeogenic pathway, control of gluconeogenesis, glycogen metabolism (glycogenolysis and glycogenesis), regulation of glycogen metabolism, electron transport chain system **Amino acids and protein metabolism:** essential aminoacids, nonessential aminoacids, glucogenic and ketogenic amino acids,	21
II	**Amino acids and protein metabolism:** amino acids biosynthesis (glutamate, glutamine, alanine, aspartate, asparagine serine, glycine, praline, cysteine, tyrosine), pathways of amino acids degradation (acetyl CoA family α- ketoglutarate family, succinyl CoA family), urea cycle. **Metabolism of Lipids and Nucleic acids:** fatty acid biosynthesis (fatty acid synthase complex, biosynthesis of long chain fatty acid, elongation of fatty acid chain, regulation), fatty acid oxidation (activation of fatty acids, role of carnitine in the transport of long chain fatty acid, β oxidation of saturated and unsaturated fatty acids, α and ω oxidation of fatty acids, regulation), biosynthesis of cholesterol, biosynthesis of purine and pyrimidine nucleotides, deoxyribonucleotides	21

Text Book:

- Instant notes Biochemistry by Hames, David

Reference Books:

Principles of Biochemistry, Author: AlbertL. Lehninger, Pub: CBS

Biochemistry, Author: Lubert Stryer, Pub: Freeman International Edition
Fundamentals of Biochemistry, Author: J.L. Jain, Pub: S. Chand and Company
Biochemistry, Author: Keshav Trehan, Pub: Wiley Eastern
Principles of Biochemistry, Author: Jeffory Zubey

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To understand basic fundamentals aspect of carbohydrates metabolism, which will help students to know about concept of Biochemistry.

CO2- To know about amino acids on the basis of metabolic aspects in order to understand their metabolism.

CO3- To study metabolism of amino acids to know about different products formed.

CO4- To understand concept of lipogenesis and lipolysis.

CO5- To study catabolism and anabolism of nucleotides and their metabolic diseases.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO5 /PSO1 PSO3
CO2	PO3, PO5, PO6 /PSO2, PSO3
CO3	PO2, PO3, PO4 /PSO1, PSO3
CO4	PO2, PO3, PO5 /PSO2, PSO3
CO5	PO1, PO4, PO5 /PSO2, PSO3

BBTC: BIOCHEMISTRY LAB

Credits: 01 **Semester IV** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I	• To carry out estimation of carbohydrate by Anthrone method • To carry out estimation of DNA by Diphenylamine method • To carry out estimation of RNA by Orcinol method • To carry out estimation of protein by Biuret method • To carry out estimation of protein by Folin- Lowry's method • To carry out estimation of cholesterol in blood serum • To carry out separation of amino acid by Paper Chromatography & determination of Rf values • To study the effect of temperature on the activity of enzyme Acid Phosphatase • To study the effect of pH on the activity of enzyme Acid Phosphatase • To perform agarose gel electrophoresis of given DNA sample	14

OUTCOME:

Exposure to various instruments used in Biochemistry. To be able to use important biochemical methods to decipher problems relevant to biology.

BBTC 0005: FOOD TECHNOLOGY

OBJECTIVES: The aim of this course is to learn the students about the-

- Role of food additives in food processing and preservation.
- Role of bacteria, yeast and mould in food processing and role of fermentation of food.
- Food borne diseases caused and food poisoning.

Credits: 03 **Semester - V** **L–T–P: 3–0–0**

Module No.	Content	Teaching Hours
I	History and Overview of Food and Industrial Microbiology. **Food Spoilage:** Spoilage of Cereals and Cereal Products, Fruits and Vegetables, Meat and Meat Products, Poultry and Eggs, Milk and Milk Products, Beers and Wines. **Bacterial Food Borne Infections and Intoxications-** *Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus* and *Vibrio.* **Food Preservation:** General Principal of Food Preservation, Aspesis, Removal, Anearobic Conditions, Low and High Temperature (pasturization, Sterilisation and Ultra High Temperature Treatment), and Drying./ Chemical Preservation of Food - Organic Acids and Their Salts, Propionates, Benzoate, Sorbate and Acetate, Nitrate, Nitrite, Sulphur Dioxide, Sulphides, Ethylene and Propiolene Oxides,Sugar and Salt, Alcohol. Benzoic Acid, Spices and Condiments. Preservation by Radiation.	18
II	**Fermented Food:** Manufacture of Fermented Foods Like Dairy Products (Acidophilus Milk, Cheeses, Yoghurt, Kefir, Kumiss), Plant Product (Cocoa Beans, Coffee Beans, Pickels, Saur-kraut) Breads and Vineger. Microbial Metabolism and Its Impacts on the Production of Various Metabolites of Industrial Importance. **Alcoholic Beverages** – Beer and Wine. **Organic acids** – Citric Acid and Lactic Acid. **Antibiotics** – Penicillin and Streptomycin. **Amino acids** – Glutamic acid. **Vitamins** – B12 **Microbial Cells as Food-** Single Cell Protein, Mushroom Cultivation.	24

Text Books:

- Food Microbiology: Frazier, W. C. And Westhoff, D.C., Tata McGraw Hill Pvt. Co. Ltd.

Reference Books:

- Food Microbiology: James, J, CBS Publisher & Distributor, New Delhi. Comprehensive Dairy Microbiology: Yadav, J S., Grover, S. & Batish, V. K., S. Chand & Co., New Delhi
- Food Microbiology: ,Adams, M. R. And Moss, M. 0., New Age International (P) Ltd. Publishers, New Delhi.
- Soil Microorganisms & plant Growth: Subbarao, N. S., Oxford & IBH Publishing Co. Pvt. Ltd., New

COURSE OUTCOMES: After completion of this course student will be able to

CO1: Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods. **(Remembering, Understand, Analyze)**

CO2: Understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods. **(Remembering, Understand)**

CO3: Know the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage. **(Remembering, Understand)**

CO4: Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation. **(Remembering, Understand, Analyze)**

CO5: Learn various methods for their isolation, detection and identification of microorganisms in food and employ in industries. ***(*Understand, *Apply)***

CO6: Understand the beneficial role of microorganisms in fermented foods and in food processing and the microbiology of different types of fermented food products – dairy, pickles, Legume and cereal based food products. **(Remembering, Understand)**

CO7: Understand of the basis of food safety regulations and discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food. **(Remembering, Understand, Analyze)**

CO8: Acquire, discover, and apply the theories and principles of food microbiology in practical, real-world situations and problems. **(Remembering, Understand, Analyze)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO2, PO4, PO5, PO7, PO8 /PSO1, PSO4
CO2	PO1,PO2 PO3, PO4, PO5, PO6/ PSO2, PSO3, PSO4
CO3	PO3, PO4, PO6, PO7, PO8 /PSO1, PSO4
CO4	PO1, PO2, PO5, PO7, PO8 /PSO3, PSO4
CO5	PO2, PO4, PO5, PO7, PO8 /PSO2, PSO4
CO6	PO3, PO4, PO5, PO7, PO8 /PSO1, PSO4
CO7	PO1, PO3, PO5, PO6, PO8 /PSO1, PSO2
	PO2, PO3, PO5, PO7, PO8 /PSO2, PSO4

BBTC 0007: MICROBIOLOGY

OBJECTIVE:

The objective of the course is to familiarize students with aspects, scopes and applications of microbiology.

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction and historical perspective -** Discovery of the microbial world, controversy over spontaneous generation, role of microorganisms in transformation of organic matter and in the causation of diseases, development of pure culture methods. **Classification and nomenclature of microorganisms** - Bacterial classification as per Bergey's manual, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining. **Methods in Microbiology** - Culture media and types, Sterilization and Disinfection – Definitions, Physical and chemical methods, pure culture techniques. **Prokaryotic Cell -** Ultrastructure and Characteristics of Prokaryotic Cell. Morphology of bacteria, bacterial cell wall, Archaeal cell walls, Cell membrane, Cytoplasmic matrix, The nucleoid, Extra chromosomal nuclear material, Intra cytoplasmic structures, Protein secretion in prokaryotes, Structures external to the cell wall (flagella, fimbrae and pili)- structure and functions. **Microbial Nutrition, Growth and Metabolism** - Common nutrient requirements, Nutrient based classification of Microorganisms, Growth factors, Growth curve, Continuous and batch culture of microorganisms. Uptake of nutrients by the bacterial cell. Peptidoglycan synthesis.	22
II	**Archae as earliest life forms**- thermophiles, psychrophiles, halophiles, alkalophiles, acidophiles, hyperthermophiles. **Viruses:** Structure and symmetry of viruses; Reproduction and life cycle of RNA and DNA viruses; Viroids and prions. **Algae and Fungi:** Classification and Reproduction. **Pathogenesis of Microbes-** Pathogenesis of microorganisms, Host-parasite relationships, pathogenesis of bacterial infection Toxigenecity (Exotoxin and Endotoxins, mechanism of action of bacterial toxins), Host defense against microbial invasion, Microbial mechanisms for escaping host defenses. **Antimicrobial Therapy-** Development of chemotherapy, General Characteristics of antimicrobial drugs, Antibacterial and Antifungal drugs, Drug resistance.	22

TEXT BOOK:

- A Text Book of Microbiology by Dubey, R.C

REFERENCE BOOKS:

- Microbiology, Authors- Pelczar, Chan and Kreig.
- Microbiology- an Introduction- (8th Edn), Authors- Tortora, G.J., Funke, B.R., Case, C.L.
- General Microbiology, Authors- Stainer, Ingharam, Wheelis and Painter.
- Microbial Physiology, Authors- Moat and Foster.
- A Text book of Microbiology, Authors- P. Chakraborty.
- Textbook of Microbiology, Authors- Dubey and Maheshwari.
- Microbiology, A Practical Approach. Authors- Patel and Phanse
- General Microbiology, Authors- Powar and Daginawala.
- Microbiology, Author- S.S. Purohit.
- Microbiology, Authors- Presscott, Herley and Klein.
- Bacteriology, Authors- Topley and Wilson.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- The students will be able to identify, culture and purify different microbial strains.
CO2- They have the knowledge to prepare and sterilize different bacterial and fungal mediums with preparation and staining of smears.
CO3- Students will gain a deep knowledge regarding to various diseases their causative agents, diseases cycle, laboratory protocols for detection and finally the methods of control and presentation of diseases.

BBTC 1804: MICROBIOLOGY LAB

OBJECTIVES: The objective of this course is well verse the students with practical knowledge of microbiology and immunology that they have taught in the theory and provide hands on training on practical techniques of microbiology and immunology related practical.

Credits: 02 **L–T–P : 0–0–3**

Module No.	Content	Lab Hours
I	• Lab safety and precautions. • To learn the working and handling of instruments used in microbiology laboratory. • Microscopic examination of bacteria by simple staining. • Gram's staining. • Endospore staining. • Capsule staining. • Isolation and maintenance of organisms by plating, streaking and serial dilution. • Preparation of culture media and slant cultures. • Measurement of bacterial population by dilution method from soil. • Isolation and identification of fungi from soil.	30

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Students will able to observe the morphology of bacteria by using different staining techniques and able to culture the bacteria and fungi in –vitro.
CO2- To identify the major categories of microorganisms and analyze their classification, diversity, and ubiquity.

BBTC 0814: IMMUNOLOGY LAB

OBJECTIVES: The objective of this course is well verse the students with practical knowledge of microbiology and immunology that they have taught in the theory and provide hands on training on practical techniques of microbiology and immunology related practical.

Credits: 02 **L–T–P : 0–0–3**

Module No.	Content	Lab Hours
I	1)To perform a differential leucocyte count. 2) To understand the basic concept of the ABO blood group system and to know our blood group and type. 3) To perform the RBC Count. 4) To detect the presence of serum antibodies to Salmonella Typhi and paratyphoid to diagnose enteric fever. 5) To learn the technique of Dot Elisa Detection of an antigen. 6) To detect the presence of Rheumatoid arthritis of Rheumatoid factor. 7) Handling of animals and Inoculation. 8) To study the Rocket Immunoelectrophoresis technique for determining the concentration of an antigen in an unknown sample. 9) To learn the technique of Ouchterlony double diffusion (antibody titration). 10) To learn the technique of Radial Immuno Assy. 11) To determine the titration value of an Antigen-Antibody affinity using the Ouchterlony Method.	30

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Students will able to observe the morphology of bacteria by using different staining techniques and able to culture the bacteria and fungi in –vitro.

CO2- To identify the major categories of microorganisms and analyze their classification, diversity, and ubiquity.

BBTC1008: MOLECULAR BIOLOGY

OBJECTIVES: Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis.

Credits: 03 **Semester IV** **L–T–P: 3–0–0**

Module No.	Content	Teaching Hours
I	Chromatin organization in Prokaryotes and eukaryotes- histone and DNA interaction . C-value paradox. DNA Replication in pro and eukaryotes. DNA repair and recombination: pyrimidine dimer, nick and gap in DNA, AP sites, b mispairing; mismatch, base excision and nucleotide-excision repair mechanisms, SO translation DNA synthesis, regulation of Y-family of polymerases in bacteria and eu Non-homologous end joining (NHEJ), Homologous recombination, Holliday model, strand break repair model, gene conversion, mating type switching in yeast, site spec recombination, FLP/FRT and Cre-Lox recombination, transposition- DNA transpos retroposons and mechanism. Gene transcription , RNA editing ,Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, transcriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small noncoding RNAs (miRNAs and siRNAs),	21
II	Regulation of gene expression: Promoters and enhancers. Transcriptional regulation regulation of lac and trp operons in bacteria, regulation by sigma factors, anti-sigma anti-sense RNA, two component regulatory system in bacteria, Concept of eukaryoti regulation, RNA in gene regulation: RNA binding proteins, RNA stability, UTR me regulation, Protein translation machinery, ribosomes-composition and assembly; universal genetic codes, degeneracy of codons, Wobble hypothesis; Iso-accepting tRNA; mechanism of initiation, elongation and termination; co- and post-translational modifications, mitochondrial genetic code. Protein Degradation. Concept of molecular medicine and gene therapy. Viral and cellular oncogenes, tumor suppressor genes from humans, structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.	21

Text book:

1. Watson, Baker, Bell, Gann, Levine and Losick. (2006). Molecular Biology of the Gene, 5 th edition, Pearson Educ

Reference books:

1. Alberts, B., Bray, D. and Hopkin, K. (2004). Essential Cell Biology. 3rd edition. Garland Science, U.S.A
2. Cox, M., Michael., Nelson,L.D. (2008). Principles of Biochemistry. 5th edition.W.H. Freeman and company, Newyork.
3. Watson, J.D. T.A.Baker, S.P. Bell, A.Lann. M.Levine and R.Losick. (2004). Molecular Biology of genes,

VIII edition, Perason Education RH Ltd., India

4. Gerald Karp (1996). Cell and Molecular Biology – Concepts and Experiments. John Wiley and Sons, Inc., New York.

5. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky and James Darnell. (2003). Molecular Cell Biology, W.H. Freeman and Company, New York.

Focus: This course focuses on Skill development aligned with CO2 & CO3

Course outcomes: After completing this course, student will able to

CO1.Understand characteristics of DNA and its primary, secondary and tertiary structure. ***(Understand)***
CO2.Understant Complexity and organization of genome in different organism. ***(Understand)***
CO3.Understand the DNA recombination and repair mechanism. ***(Understand)***
CO4. Understand the semi-conservative mode of replication in prokaryotes and eukaryotes. ***(Understand)***
CO5. Describe process of transcription in prokaryotes & eukaryotes. ***(Understand)***
CO6. Analyze nature & causes of cancer and the genes involved in cancer. ***(Understand and Analyse)***
CO7 Describe Operon concept, bacterial gene regulation &eukaryotic gene regulation. ***(Understand)***
CO8. Analyze the genetic code and describe the Translation and post translation modification process. ***(Understand and Analyse)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1, PO4, PO5 /PSO2, PSO3
CO2	PO2, PO4, PO6/PSO1, PSO3
CO3	PO1, PO3, PO4 /PSO2, PSO3

BBTC0009: RECOMBINANT DNA TECHNOLOGY

OBJECTIVES: 1. To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences. 2. To expose students to application of recombinant DNA technology in biotechnological research. 3. To train students in strategizing research methodologies employing genetic engineering techniques.

Credits: 03 **Semester IV** **L–T–P: 3–0–0**

		Teaching Hours
I	Introduction: Milestones in genetic engineering and biotechnology. Simple cloning of DNA fragments, Vectors: Definition and properties. Transformation of DNA by chemical method and electroporation. **Vectors:** Cloning Vectors- Definition and Properties. Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors. Cosmids. Shuttle vectors BACs, YACs, MACs Baculovirus based vectors. Ti based vectors (Binary and Cointegrated vectors) and cloning using linkers and adaptors. Terminal deoxynucleotidyl transferase, kinases and phosphatases, DNA ligases and DNA polymerases, reverse transcriptases, bacteriophage RNA polymerases, exonuclease III, BAL31, mung bean nuclease, S1 nuclease. Mammalian Expression Vectors- SV40, Vaccinia, Retroviral promoter based vectors. Restriction modification systems: Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. Modification of cut ends DNA modifying enzymes and their applications.	21
II	Introduction of Recombinant DNA into suitable host,reported gene, Elimination of non transform cells. Identification of clones having recombinant DNAs. Sequence dependent screening and Expression based screening. production of recombinant proteins. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction. Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis. **Construction of genomic libraries:** Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony PCR. **DNA sequencing and product of DNA technology:** Maxam-Gilbert's and Sanger's method. Automated sequencing. Human genome sequencing project. Human protein replacements-insulin, hGH and Factor VIII Human therapies – tPA, interferon, antisense molecules. Guidelines for GMO's and Ethical issue related with GMO's.	21

Text book:

1.B. R. Glick., et al. Molecular Biotechnology: Principles & Applications of Recombinant DNA (ASM Press, ed. 4, 2009).

Reference books:

1.M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor, ed. 4, 2012). 2. M. Wink. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology (Wiley, ed. 2, 2011) .

3. K. Wilson, J. Walker. Principles and Techniques of Biochemistry and Molecular Biology (Cambridge University Press, ed. 7, 2010).

4. S. B. Primrose, R. Twyman. Principles of Gene Manipulation and Genomics (Wiley-Blackwell, ed. 7, 2006).

5. M. M. Burell. Enzymes of Molecular Biology (Humana Press, 1993). 7. H.M. Eun. Enzymology. Primer for Recombinant DNA Technology (Academic Press, 1996).

Focus: This course focuses on Skill development aligned with CO2 & CO3

Course outcomes: After completing this course, student will able to

CO1: Describe the role of various enzymes as molecular tools for genetic manipulation **(*Remembering and Understand*)**
CO2: Gene amplification by various molecular techniques (***Remembering, Understand and Apply***)
CO3: Describe the restriction enzymes and different vector systems as molecular tools for cloning **(*Remembering and Understand*)**
CO4: Introduce DNA into cells by transformation and identify recombinant cells (***Understand and Analyse***)
CO5: Select the clones by various molecular techniques (***Understand and Analyse***)
CO6: Acquire the knowledge on various types of sequence reactions and gene mapping methods (***Apply and Evaluate***)
CO7: Explore the expression of cloned genes and protein production (***Apply, Evaluate and create***)
CO8: Explain genomic and cDNA library construction for cloning and applications of genetic engineering (***Understand***)
CO9: Apply theoretical knowledge of Recombinant DNA Technology for the development of new recombinant DNA molecules (***Understand***, ***apply, analyse and create***)

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1, PO4, PO5 /PSO2, PSO3
CO2	PO2, PO4, PO6/PSO1, PSO3
CO3	PO1, PO3, PO4 /PSO2, PSO3

BBTC0803: RDT AND MOLECULAR BIOLOGY LAB

OBJECTIVES: 1. To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences. 2. To expose students to application of recombinant DNA technology in biotechnological research. 3. To train students in strategizing research methodologies employing genetic engineering techniques.

Credits: 02 **Semester IV** **L–T–P: 0–0–2**

Content
1. Isolation of Bacterial genomic DNA 2. Qualitative analysis of Genomic DNA 3. Quantitative analysis of Genomic DNA 4. Isolation of Plasmid DNA 5. Restriction enzyme digestion of pUC18 DNA 6. Ligation of DNA fragment with cloning vector 7. Preparation of Competent cells 8. Transformation in E.coli with recombinant vector 9. Polymerase Chain Reaction 10. Southern Hybridization

Text book:

1.Sambrook, J., Russell, D. W., & Russell, D. W. (2001). Molecular cloning: a laboratory manual (3-volume set).

Reference books:

1.M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor, ed. 4, 2012). 2. M. Wink. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology (Wiley, ed. 2, 2011) .

3. K. Wilson, J. Walker. Principles and Techniques of Biochemistry and Molecular Biology (Cambridge University Press, ed. 7, 2010).

4. S. B. Primrose, R. Twyman. Principles of Gene Manipulation and Genomics (Wiley-Blackwell, ed. 7, 2006).

5. M. M. Burell. Enzymes of Molecular Biology (Humana Press, 1993). 7. H.M. Eun. Enzymology. Primer for Recombinant DNA Technology (Academic Press, 1996).

Focus: This course focuses on Skill development aligned with CO2 & CO3

Course outcomes:

CO1.Technical know-how on versatile techniques in recombinant DNA technology.

CO2. An understanding on application of genetic engineering techniques in basic and applied experimental biology.

CO3. Proficiency in designing and conducting experiments involving genetic manipulation.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1, PO4, PO5 /PSO2, PSO3
CO2	PO2, PO4, PO6/PSO1, PSO3

BBTC XXXX : FERMENTATION TECHNOLOGY

OBJECTIVES: Fermentation technology course helps students to apply the concepts learned in the area of microbiology, biochemistry for obtaining commercially important byproducts. Students are introduced to the concept of fermentation technology, scaling up techniques, wet & dry milling and the concepts, components of a bioreactor enabling students to learn the concept of aerobic, anaerobic and alcoholic fermentation leading to the production of cheese, butter, yoghurt, etc.

Credits:03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	**Introduction to Fermentation Technology:** History and development of fermentation industry: Types of fermentations processes. Design of typical batch fermenter, Agitation, Aeration, pH, Temperature, and dissolved oxygen. Factors affecting fermenter design. Types of fermenters/bioreactors. **Microorganisms:** Isolation of industrially important microorganisms, primary and secondary screening, isolation methods utilizing selection of desired characteristics, culture preservation and maintenance, inoculum development, strain development strategies. primary and secondary metabolite improvement of industrial microorganisms for overproduction of primary and secondary metabolites. **Media for industrial fermentations:** Media requirements for fermentation processes, simple and complex media, medium formulation, carbon sources, nitrogen sources, minerals, vitamins and other nutrients, precursor, inducers, chelator, growth factors, inhibitors, and antifoams. Media Optimization, Animal Cell Media	21
II	**Sterilization:** Sterilization methods; Media sterilization, del factor, thermal death kinetics of cells and spores: survival curve decimal reduction factor, types of media sterilization- batch and continuous sterilization- design aspects, Sterilization of fermenter, sterilization of waste, sterilization by filtration, sterilization of air and liquids. **Commercially important products:** Alcohol, alcoholic beverages beer and wines etc, organic acids, acetone, butanol etc., enzyme and amino acids, single cell proteins, baker's yeast, high fructose corn syrup, secondary metabolites -antibiotics, production of heterologous proteins by bacteria and yeast etc. **Downstream Processing** Solid liquid separation method. protein precipitation, adsorption, aqueous two-phase extraction Filtration - membrane filtration, ultra filtration; Centrifugation - high speed and ultra; Cell disruption; Principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity, GC, HPLC and FPLC; Extraction, adsorption and drying.	21

TEXT BOOK:

- Principle of Fermentation Technology by Stanbury, O.F

REFERENCE BOOKS:

- Murray Moo -Young, Comprehensive Biotechnology, Vol. 1 & III.
- Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication
- Industrial Fermentations- Leland, N. Y. Chemical Publishers.
- Prescott and Dunn's- Industrial Microbiology.
- Biotechnology Series, Rehm, Reed & Weinheim, Verlag-Chemie.
- Biochemical Engg., Aiba, Humphrey & Miller, Academic Press.
- Fermentations & Enzyme technology,Wang & Humphrey, Wiley & Inter Science

FOCUS: This course focuses on Entrepreneurship, Skill development aligned with all COs.

COURSE OUTCOMES: After completing this course, student will able:

CO1-Understand basic concepts of fermentation technology. ***(Understand)***
CO2 - Understand design, working, computational control and applications of Bioreactor/Fermenter. ***(Understand and Analyze)***
CO3 - Understand principles and strategies involved in media formulation and strain development. ***(Analyze)***
CO4 - Understand the concept of feedback mechanisms such as inhibition and repression. ***(Analyze)***
CO5 - Understand the concept of recombinant microbial cells and their significance in fermentation technology. ***(Understand and Analyze)***
CO6 - Understand downstream processing and factors affecting the phenomena. ***(Analyze)***
CO7 -To develop novel ideas in the area of fermentation technologies and their applications agents. ***(Create)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Cos	POs/ PSOs
CO1	PO1, PO3, PO5, PO7, PO8/PSO2
CO2	PO1, PO2, PO3, PO4, PO7, PO8/PSO1, PSO3
CO3	PO1, PO3, PO7, PO8, PO9/PSO1, PSO3
CO4	PO2, PO3, PO5, PO5, PO8, PO10/PSO1, PSO2
CO5	PO1, PO2, PO3, PO5, PO7, PO8, PO10/PSO2, PSO3
CO6	PO2, PO3, PO5, PO7, PO8, PO9/PSO1, PSO3
CO7	PO1, PO2, PO3, PO4, PO7, PO8/PSO1, PSO3

BBTC XXXX : Bioprocess Engineering

Course Objectives: The objective of this course is to impart knowledge on fundamentals of bioprocessing and bioreactor operations. To explain the principles of bioreactors and their application to upstream and downstream processing.

Credits:03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	**Introduction to Bioprocesses:** An Overview of bioprocess engineering, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, generalized process flow sheets. **Microbial Growth Kinetics:** Kinetic modelling of cell growth: model structure, structured and un-structured models, Monod chemostat model, models with growth inhibitors, growth models for filamentous organisms structured kinetic models. Production kinetics in cell culture, Growth associated and non - growth associated product formation kinetics. Elemental balances- respiratory quotient, Yield and maintenance coefficients. Stoichiometry of growth and product formation, Maximum possible yield, degree of reduction, electron balance and theoretical oxygen demand. . **Ideal Reactor Operation:** Batch, Fed Batch & Continuous operation of mixed bioreactors, Microbial pellet formation, Kinetics and dynamics of pallet formation. substrate utilization and product formation in bioreactor, Chemostat with immobilized cells, Chemostat with cell recycle, Enzyme immobilization, diffusion effects - Thiele modulus, effectiveness factor, Damkoehler number; Scale up of Bioreactors.	21
II	**Introduction To Transport Phenomena: Mass Transfer and heat Transfer** Newtonian and non-Newtonian fluids, fluid flow - laminar and turbulent; Mixing in bioreactors, mixing time, Mechanisms of mass transport, molecular and diffusion theory, role of diffusion in mass transfer, film theory, types of mass transfer, mass transfer in bioprocessing systems: gas liquid mass transfer, the oxygen requirement for industrial bioreactors, Volumetric oxygen transfer, oxygen transfer mechanism- assessment of K_La and its determination methods, factors affecting K_La, fluid rheology, effect of medium rheology on K_La, fluid flow and mixing in fermentation broths, factors affecting agitation in bioreactor, Conductive and convective heat transfer, LMTD, overall heat transfer coefficient; Heat exchangers. **Bioreactor control mechanism:** Fermentation monitoring, measurement analysis, Fault analysis, Process modelling, Feedback and feed forward control; Types of controllers – proportional, derivative and integral control, tuning of controllers. Indirect metabolic control, Programmed control, Application of Artificial Intelligence in Bioprocess control	21

Text Book:

- Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press

Reference Books:

- "Biochemical Engineering Fundamentals '' by J.E. Bailey and D.F.Ollis, McGraw –Hill Book Co., New YorkPlant Biotechnology by Hammond *et al*
- Bioprocess Engineering Basic Concepts. 2nd edition.. Michael L. Shuler and Fikret Kargi, Prentice Hall, Upper Saddle River, NJ.Plant Cell & Organ culture by Gamberg, O.L
- Bioprocess Engineering Principles Pauline Doran, Academic Press, London.
- T Panda, Bioreactors analysis and design, Tata McGraw Hill, New Delhi, New York, 2011.
- Plant Molecular Biology- vol.I and II, Gimartin& Bowler

After completing this course, student will able to

CO1-Understand the the principles and operations of various bioreactor modes. ***(Understanding)***
CO2-Learn the Fluid properties and role of diffusion in Biorector process. ***(Understanding)***
CO3- Understand basic principles of mass and energy conservation to analyze bioreactor systems ***(Remembering and Understanding)***
CO4- Understand the media preparation and sterllization... ***Remembering and Understanding)***
CO5- Understand the kinetics of microbial growth and the associated parameters. **(*Remembering and Understanding)***
CO6- Analyze the concept of bioreactor control mechanism and identify suitable control system. **(*Analysing)***
CO7- Understand the Understand necessity of DSP and factors influencing choice of methods for DSP. **(*Remembering and Understanding)***

BBTC0010: IMMUNOLOGY

Course Objectives: This course will enable students to

- Learn the underlying concepts of molecular and cellular mechanisms involved in the developmentand regulation of the immune response
- Describe the cause and treatment for Immune System Pathologies and Dysfunctions.
- Learn the importance techniques of Immuno diagnosis.

Credits:03 **L-T-P:3-0-0**

Module	Contents	Teaching Hr.
1	Cells and organs of immune system, Process of hematopoiesis and role of each cells, primary and secondary lymphoid organs, innate and acquired immunity, Humoral and Cell mediated immunity. Antigens: Chemical and biological Factors affecting antigenicity/Immunogenicity and molecular nature, Haptens, adjuvants, Antibodies: their structure and function, Immunoglobulin classes and subclasses (isotypic, allotypes, idiotypes and anti-idiotytopic antibodies). B-lymphocytes and their activation, Class switching mechanism , antibody genes and generation of diversity, production of monoclonal antibodies,polyclonal antibodies and applications, cytokines, Thymus derived lymphocytes (T cells) - their ontogeny and types,Activation of T- cells, Major histocompatibility Complex (MHC) Complex - MHC Class I and II molecules. Antigen processing and presentation process. Complement system and its pathways, Hypersensitivity . Immune response to infections: immunity to viruses, bacteria, fungi and parasites,	
2	Immunodeficiency disorders: Primary and secondary (AIDS). Injury and inflammation, Vaccines and their types, classification and immunization schedule . Transplantation and its classification, Immunologic basis of graft rejection and its mechanism , Transplantation antigens, tissue typing role of MHC molecules inallograft rejection, Clinical transplantations, bone marrow, HSC transplantation and immune suppressive therapy. Tumors of the immune system, tumor antigens and immune response to tumors, tumor immunotherapy. Antigen antibody interaction – Precipitation reactions, Agglutination reactions, Principles and applications of ELISA, Radio Immuno Assay (RIA), western blot analysis, immunoelectrophoresis, Immunofluorescence, chemiluminescence assay, fluorescence activated cell sorting (FACS) analysis. Role of stem cells technology inimmunology, Production of humanized monoclonal antibodies (Single chain fragment variable), immunotherapy with genetically engineered antibodies,	

Learning Outcomes:

On completion of the course, the student should be able to:

CO1. Learn the key concepts of immunological mechanisms and our body respond towards pathogen attack. (Remembering and Understand)
CO2. How this could be extrapolated towards development of novel therapeutic interventions against various diseases. (Understand, Analyze and Apply)
CO3. This course will explain the role of immune response in infectious diseases and help in understanding the biology behind the allergic reactions among people. (Understand, and Remembering)
CO4. To apply immune associated mechanism in medical biotechnology research. (Understand and Remembering)
CO5. Course will be able to explain the procedure for the antigen-antibody interaction-based test and their specificity and sensitivity. (Understand, Analyze and Apply)
CO6. Able to understand the procedure for vaccines development and their applications. (Remembering and Understand)
CO7. Able to understand different immunological techniques and their applications in disease diagnosis. (Understand, Analyze and Apply)

Text Books:

1. Immunology by Kuby (Free man publication)
2 Immunology &Immunotechnology Ashim K Chakravarthy Oxford University Press 20063
Immundiagnostics S C Rastogi New Age International 1996

Reference Books

1 Essential Immunology Roitt I. Blackwell Scientific Publications, Oxford 13th Edition 2017
2 Immunology: A Short Course Richard Coico, Geoffrey Sunshine Wiley-Blackwell 7th Edition 20153 Understanding Immunology Peter Wood Pearson Education 2001
4. Immunology – an Introduction Tizard Thomson. 198

BBTC 0014 : PLANT BIOTECHNOLOGY

OBJECTIVES: To provide knowledge of different techniques for the utilization of Plant material in agriculture and to combat the disease associated with the crop and utilize the tissue culture techniques for the production of valuable products as well as provide the idea how plant can be useful for the human welfare.

Credits:03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	**Introduction to plant tissue culture:** The concept of biotechnology, landmarks in biotechnology, Plant tissue culture – Principles and techniques, Cellular totipotency, in vitro differentiation; dedifferentiation and redifferentiation, Callus induction organogenesis and somatic embryogenesis, Tissue culture medium; Basic components in tissue culture medium – Solid and liquid medium, Murashige and Skoog medium, Aseptic techniques in tissue culture – sterilization – different methods sterilization of instruments and glass wares, medium and explants, Establishment of axenic cultures production of suspension culture. Concept of micropropagation; advantages and disadvantages, different methods – axillary bud proliferation, direct and indirect organogenesis and somatic embryogenesis, Different phases of micropropagation – hardening, transplantation and field evaluation. Synthetic seed production, Meristem culture, Somaclonal variation and in vitro mutagenesis, Embryo rescue – embryo culture. In vitro production of haploids – anther and pollen culture; in vitro fertilization, Double haploid production. Cryopreservation and slow growth for germplasm conservation. Protoplast fusion, selection of hybrid cells; symmetric and asymmetric hybrids, cybrids	21
II	In vitro secondary metabolite production — cell immobilization, bio reactors, hairy root culture. Plant transformation: Genetic engineering: Vectors for plant transformation, Different types of Agrobacterium based vectors. methods of transformation – electroporation, particle bombardment and Agrobacterium mediated. Target traits and transgenic crops; Genetic and molecular analyses of transgenics. Molecular Markers: Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars. GMO: Achievements and issues. Examples of transgenic plants produced successfully: Bt crops, golden rice, Flavr Savr Transgenic plants: insect resistance, virus resistance, abiotic stress tolerance, lon shelf life (including strategies for suppression of endogenous genes), male sterilit enhanced nutrition (golden rice), edible vaccines. Bio-pigments: Extraction of biocolours, uses in food and textile industries. Protection of plant variety and farmers right act; Convention on biological diversity. Improvement of reserve food material in seed, flower, fruits and plants. Socio economic impact of plant biotechnology.	21

Text Book:

- Biotechnology by Singh, B.D

Reference Books:

- Plant Tissue Culture: Theory & practice by Bhojwani&Rajdan
- Plant Biotechnology by Hammond *et al*
- Plant Tissue Culture –Bhojwani, S.S.
- Plant Cell & Organ culture by Gamberg, O.L
- Principles of Plant Biotechnology, Montell, *et al*
- Plant Cell Culture by Evans D.A.
- Plant Molecular Biology- vol.I and II, Gimartin& Bowler

After completing this course, student will able to

CO1-Acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization & measures adopted for aseptic manipulation and nutritional requirements of cultured tissues. ***(Understanding)***

CO2-Learn the techniques of culturing tissues, single cells, protoplasts & anther culture, germplasm conservation and cryobiology. ***(Understanding)***

CO3- Learn the large scale clonal propagation of plants through various micropropagation techniques, Production of secondary metabolites under in vitro conditions. ***(Remembering and Understanding)***

CO4- Understand the different transformation techniques of genes in plants cells. ***Remembering and Understanding)***

CO5- A good understanding of r-DNA technology, methods of gene transfer, molecular markers and marker assisted selection. **(*Remembering and Understanding)***

CO6- Develop transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement. **(*Remembering and Understanding)***

CO7- Understand the Bio-safety guidelines for research involving GMO's, benefits and risks. **(*Remembering and Understanding)***

BBTC 0807: PLANT BIOTECHNOLOGY LAB

OBJECTIVES:

To well verse the students with practical knowledge of plant biotechnology that they have taught in the theory and provide hands on training on practical techniques of plant tissue culture and applications of Plant Biotechnology in daily life.

Credits: 02 **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	• Preparation of media for plant tissue culture. • Sterilization of plant tissue. • Callus induction from different explants: - seed, root & shoot. • Anther, Embryo and Endosperm culture. • Isolation of protoplast and culture • Demonstration of Isolation of Plant genomic DNA. • Viability testing of seeds under different environmental conditions • Isolation of nitrogen fixing organisms like Cyanobacteria and Rhizobium and their characterization. • Somatic embryogenesis and synthetic seed production • Analysis of total protein content of seeds by TCA precipitations method. • Isolation and cultivation of mushroom. • Isolation and study of fungus responsible for food spoilage.	30

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To prepare different explant culture, essential oil extraction and perform the fermentation experiment.

CO2- Students will familiar with Protoplast isolation and fusion.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO3, PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1,PO2, PO3, PO6, PO7, PO8 /PSO1, PSO2

BBTC 0013 : ANIMAL BIOTECHNOLOGY

OBJECTIVES: To provide knowledge of different techniques for the utilization of animal cell and their utilization the cell culture techniques for the production of valuable products as well as provide the idea how animal cells can be useful for the human welfare.

Credits:03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	Introduction to basic tissue culture techniques; Types of cell culture media; Ingredients of media; Physiochemical properties; CO2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Role of serum in cell culture, chemically defined media and serum free media; Types of cultures: Primary culture, Adherent cultures, Suspension cultures, Cell line, Tissue and organ culture.; Cytotoxicity and viability assays; Subculture and propagation, Cell lines, Nomenclature, Cell line designations, Routine maintenance, Cryopreservation of cell lines, Immortalization of cell lines, Cell culture reactors; Scale-up in suspension; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Nunc cell factory; Roller culture; Microcarriers; Perfused monolayer cultures	21
II	Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins, Over-production and processing of proteins. Application of animal cell culture for *in vitro* testing of drugs. Gene transfer techniques in mammalian cells, Viral and nonviral methods, Production of transgenic animals, ES and microinjection, retroviral method and molecular pharming, Applications of transgenic animal technology. Embryo transfer technology, Techniques used in Assisted Reproductive Technology: ICSI, ZIFT, GIFT; artificial insemination, Steps involved in *In-vitro* fertilization (IVF) and embryo transfer; Super ovulation strategy; embryo sexing and embryo splitting; cryopreservation of embryos,Application of Embryo transfer technology, Animal cloning basic concept, Techniques, relevance and ethical issues, SCNT.	21

Text Book:

1. Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 8th EditionWiley –Blackwell.2021

Reference Books:

2. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000

3. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991

4. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003. 5. Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5th Edition, CRC Press, 1997

5.Wilson Aruni A and RamadassP,(2011).Animal Tissue Culture, MJP Publishers

6. Ranga M.M.(2002) Animal Biotechnology. Agrobios India Limited.

After completing this course, student will able to

CO-1: To learn the basic aseptic skills for animal tissue culture.
CO-2: Understand the composition of different types of medium and the role of serum used in cell culture.
CO-3: To gain knowledge about different types of cell culture methods and their benefits.

CO-4: Develop proficiency in mammalian cell culture and the maintenance of cell lines.

CO-5: Can apply the knowledge of cryopreservation and recovery techniques in stem cell banking industries

CO-6: To make the students to understand the concepts and application of animal cell culture for the production of pharmaceutical products.
CO-7: To impart knowledge on production of transgenic animals and how to improve the meat and milk production
CO-8: To enable Students to develop basic skills to understand the principles of IVF and animal cloning with its applications.

BBTC 0806 : ANIMAL BIOTECHNOLOGY LAB

COURSE OBJECTIVES: The objective of this laboratory includes synthesis, production and applications of nanoparticles.

Credits: 02 Semester III L–T–P: 0–0–3

Module No.	Content	Lab Hours
I	• Introduction to cell culture laboratory and instruments (Inverted microscope, CO 2 incubator, Refrigerated centrifuges, Bio-safety cabinets, Cryo cans, UV lights etc) used in thelab • Washing and Sterilization of glass wares, plastic ware and different buffer/ media for animal tissue culture • Preparation of tissue culture medium • Separation of lymphocyte from Peripheral blood monocular cells. • Cell counting by haemocytometer • Cell viability assay by trypan blue method. • Preparation of single cell suspension from spleen / thymus • Trypsinization of monolayer and sub culturing of cells • Cell proliferation assay by MTT method • Cryopreservation and revival of cells	15

Reference Books:

2. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000

3. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991

4. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Well acquainted with the animal cell culture lab and the instruments used in the lab.
CO2- Can able to prepare and properly sterilize the chemicals and glass wares for animal cell culture.
CO3- Can able to prepare and sterilize balance salt solutions and medium to grow the cells in vitro.
CO4- Successfully prepare the primary cultures of animal cells
CO5- Can able to count the number of cells and quantitate its percentage viability
CO6-Can able to assess the animal cell growth/ health in in vitro cultures.
CO7- Can able to maintain the cell lines and store them by cryopreservation.

BBTE : ENZYME ENGINEERING & TECHNOLOGY

OBJECTIVES: The objective of this course is to well versed students with basic concepts of Enzyme technology

Credits: 03 **L–T–P: 3–0–0**

Module No.	Content	Teaching Hours
I	• **General introduction:** Nomenclature and Classification of enzymes, Types of specificity, Active sites. Enzyme activity—chemical nature of enzymes. Protein nature of enzymes and nonprotein enzymes—ribozymes and DNAzymes. Coenzymes and Cofactors—prosthetic group, coenzymes involved in different metabolic pathways. Enzyme-substrate interaction: Lock and Key mechanism, Induced Fit mechanism, transition state Hypotheses, Enzyme function, and general mechanism. • **Kinetics of free enzymes:** Basic concepts of bioenergetics, Factors affecting the rates of chemical reactions, Enzyme Kinetics: Michaelis-Menten Equation, Measurement of Km and Vmax, Enzyme inhibition: Reversible (competitive, uncompetitive and mixed) and irreversible, Kinetics of multisubstrate reaction: Sequential reactions and ping-pong reactions. Multienzyme complex and multifunctional enzymes, Kinetics of allosteric enzymes and enzyme regulation.	18
II	• Immobilized enzymes: Principles & techniques of immobilization, Immobilized enzyme reactions; Analysis of mass transfer effects on kinetics of immobilized enzyme reactions, Analysis of film and Pore diffusion effects on kinetics of immobilized enzyme reactions, Calculation of effectiveness factors of immobilized enzyme systems. • Production and Application of Enzymes: Sources of industrial enzymes (natural and recombinant), Strategies of isolation and purification of new enzymes from different sources, Large-scale production of enzymes including genetic engineering approaches for their over production, downstream processing (salt precipitation, gel filtration, ion exchange and affinity chromatography), • Applications of enzymes in the food industry, detergents, energy, waste treatment, pharmaceutical, medical, and analytical purposes.	24

TEXT BOOK:

- Enzyme Technology by S. Shanmugam & T. Satishkumar, Pub: I.K.International

REFERENCE BOOK:

- Understanding Enzymes by T.Palmer, Pub: Ellis Horwood Limited
- Fundamentals of Enzymology by Nicholas C. Price & Lewis Stevens, Pub: Oxford University Press

FOCUS:

COURSE OUTCOMES: The main outcomes of this course are:

CO1- Acquire the knowledge of enzymes, their properties and classification, Mechanism of action, Michaelis-Menten initial rate equation, methods for the determination of Km and Vmax. ***(Understand, Analyze and Apply)***

CO2- Learn about enzyme kinetics, effect of enzymes concentration, pH and temperature on kinetics of enzyme reactions, enzyme inhibition and activation, and Multisubstrate enzyme kinetics. ***(Understand, Analyze and Apply)***

CO3- Acquire fundamental knowledge on enzymes and their importance in biological reactions. ***(Understand)***

CO4- Understand various mechanism of regulation of enzyme activity. ***(Understand and Analyze)***

CO5- Understanding the role of enzymes in clinical diagnosis and industries. ***(Understand, Analyze and Apply)***

CO6- Learn and Understand various techniques of enzyme purification. ***(Understand, Analyze and Apply)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1, PO3, PO4, PO5, PO6, PO7, PO8/PSO1, PSO2
CO2	PO1, PO2, PO4, PO5, PO6, PO7, PO8/PSO1, PSO2
CO3	PO1, PO3, PO4, PO6, PO7, PO8/PSO1, PSO2
CO4	PO1, PO3, PO4, PO5, PO6, PO7, PO8/PSO1, PSO2
CO5	PO1, PO3, PO4, PO5, PO6, PO7, PO8/PSO1, PSO2
CO6	PO1, PO3, PO5, PO6, PO7, PO8/PSO1, PSO2

BBTC: FOOD AND ENZYME ENGINEERING & TECHNOLOGY LAB

COURSE OBJECTIVES: The objective of this laboratory includes determination of food quality, microbial testing and food preservation.
Isolation of different enzymes and their activity.

Credits: 02 **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	• Introduction to laboratory equipments and safety in food technology lab. • Determination of carbohydrates, proteins, lipids and fibre in food samples. • Microbial analysis of foods. • Food Preservation techniques demonstration. • To demonstrate the activity of the enzyme amylase extracted from the germinating barley or pea seeds. • To study the enzyme activity of diastase in germinating seeds of barley and to study the influence of pH and temperature. • To demonstrate the activity of peroxidase in plant material. • Identification of enzymes in different sources. • Isolation of α Amylase from different sources. • Determination of α Amylase Enzyme activity.	15

Reference Books:

2. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000

3. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991

4. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.

COURSE OUTCOMES: The major outcomes of this course are:
CO1- Well acquainted with the determination of carbohydrates, proteins, lipids and fibre in food samples.
CO2- Can able to do microbial analysis of foods.
CO3- Can able to food Preservation techniques.
CO4. Can able to do Isolation of different enzymes and their activity

TEXT BOOK:

- Enzyme Technology by S. Shanmugam & T. Satishkumar, Pub: I.K.International

REFERENCE BOOK:

- Understanding Enzymes by T.Palmer, Pub: Ellis Horwood Limited
- Fundamentals of Enzymology by Nicholas C. Price & Lewis Stevens, Pub: Oxford University Press

BBTE-0002 ALGORITHM FOR BIOINFORMATICS

OBJECTIVES: Algorithm for bioinformatics is an interdisciplinary program offering substantial training in both the biological sciences and the physical and mathematical sciences; our program emphasizes the integration of computer science with genetics and molecular biology.

Credits: 03 **L–T–P: 3–0–0**

Module No.	Content	Teaching Hours
I	Introduction to molecular biology	14
	Introduction to Bioinformatics & Biological Databases Primary, Secondary and composite database Sequence of Nucleic Acids and Proteins, Specialized Sequence Databases of Expressed Sequence Tags, Single Nucleotide Polymorphism, OMIM. **Algorithms & Tools** Sequence Alignment (Pair wise and Multiple), Alignment Algorithms, Amino Acid Substitution Matrices (PAM, BLOSUM), Profiles. Hidden Markov Models, Needleman-Wunsch Algorithm for global sequence algorithm, and Smith Waterman algorithm for local sequence algorithm.	18
II	Protein Structure Prediction (Secondary and Tertiary), *ab intio*, Homology Modeling, Threading, Micro Array Data Analysis. **Applications of Bioinformatics in Biotechnology Research** PCR Primer designing, Structure Visualization Methods (PyMol, JMol, RasMol), Structure Classification (SCOP, CATH), Bioinformatics Application in Drug target identifications, Computer aided Drug Designing.	24

TEXT BOOK:

- Bioinformatics: Concepts, Skills and Application by Rastogi, S.C

REFERENCE BOOKS:

- B N Mishra, Bioinformatics: Concept and application, Pearson Education (in Press)
- O'Reilly: Developing Bioinformatics Computer Skill.
- Anthony JF Griffths et al: An intro to Genetic analysis.
- Michael Starkey and Ramnath Elaswarapu; Genomcis Protocols, Humana Press
- Stephen Misner & Stephen Krawetz Bioinformatics Methods and Protocols
- Lawrence Hunter – Artificial Intelligence & Mol. Biology, free on web
- Westhead P: Instant notes on Bioinformatics; Viva Publication
- Hooman H Rasidi Bioinformatics Basic Application in Biological Science and medicine; CRC Press.

FOCUS: This course focuses on Employability, Skill development aligned with CO1 & CO2

COURSE OUTCOMES: After completion of course, the student will be able to:

CO1: Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics. ***(Understand, Remember and Apply)***

CO2: To acquire an ability of knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics. ***(Understand, Remember and Analyze)***

CO3: Ability to understand existing software effectively to extract information from large databases and to use this information in computer modeling. ***(Understand, Remember, Analyze and Apply)***

CO4: Ability to apply an understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries. ***(Understand, Remember, Analyze and Apply)***

CO5: Ability to understand the overview about biological macromolecular structures and structure prediction methods. ***(Understand, Remember and Apply)***

CO6: Ability to the basic concepts of Bioinformatics and its significance in Biological data analysis. ***(Understand and Remember)***

CO7: Students will be able to engage professionally in problem-solving skills, including the ability to develop new algorithms and analysis methods. ***(Understand, Remember Analyze and Apply***

BBTC0006: BIOANALYTICAL TECHNIQUES I

Course Objectives:

The primary objectives of this course are to develop the skills to understand the basics of bio analytical techniques used in biotechnology.

Credits: 02

Module No.	Contents	Teaching Hours (Approx.)
I	Microscopy: Principals, instrumentation and applications of imaging techniques: Dark-field, Phase contrast, Fluorescence, Confocal microscopy, Atomic force microscopy, and Transmission and Scanning electron microscopy. Centrifugation: Basic principle & theory, types of centrifuges- Micro centrifuge, High speed & Ultracentrifuges. Preparative centrifugation: differential & density gradient centrifugation. Analytical centrifugation & its applications	20
II	Electrophoretic Techniques: Principle, equipment and process, Agarose gel electrophoresis, horizontal and vertical gel electrophoresis, electrophoresis techniques, Isoelectric focusing, capillary electrophoresis and application of electrophoresis in analysing macromolecules. Radioactivity : Radioactive decay, Measurement, Radiotracer Technniques, Radioimmunoassay, Clinical application.	20

Learning Outcomes:

CO1.To be able to use selected analytical techniques.

CO2.Familiarity with working principals, tools and techniques of compound microscope.

CO3. To be able to workinghuse .

Text Books:

I. D. Campbell, Biological spectroscopy (Benjamin/Cummings Pub. Co, Menlo Park, Calif, 1984), Biophysical techniques series.

2. K. Wilson, J. M. Walker, Eds., Principles and techniques of biochemistry and molecular biology (Cambridge University Press, Cambridge, UK : New York, 7th ed., 2009).

Reference Books:

1. R. F. Boyer, Biochemistry laboratory: modern theory and techniques (Prentice Hall, Boston, 2nd ed., 2012).
2. R. Katoch, Analytical techniques in biochemistry and molecular biology (Springer, New York, 2011). 3. D. L. Spector, R. D. Goldman, Eds., Basic methods in microscopy: protocols and concepts from cells: a laboratory manual (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y, 2006).
4. J. R. Lakowicz, Principles of fluorescence spectroscopy (Springer, New York, 2006;
5. D. Harvey, Modern analytical chemistry (McGraw-Hill, Boston, 2000).

BBTC0006: BIOANALYTICAL TECHNIQUES II

Course Objectives:

The primary objectives of this course are to develop the skills to understand the basics of bio analytical techniques used in biotechnology.

Credits: 02

Module No.	Contents	Teaching Hours (Approx.)
I	Spectroscopy study of chemical compounds and bio-molecules Electromagnetic radiations and interactions with matters: Electromagnetic spectrum. Quantisation of energy, Electronic, vibrational and rotational spectroscopy. Franck–Condon principle, Jablonski diagram, radiative, nonradiative pathways, fluorescence and phosphorescence. Absorption of radiation, BeerLambert's law, deviation of Beer-Lambert's equation and its limitations. Principals, instrumentation, sampling and application of few spectroscopic techniques: UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy, CD & ORD Spectroscopy. Flow cytometry: Types of detectors, Gating, Hydrodynamic focusing, 2D plots, Applications in medical and research fields	14
II	Chromatography: Classification of chromatographic techniques and their principles, Theory of chromatography, band broadening, rate and plate theory factors responsible for separation. Column chromatography, TLC, Paper chromatography. Liquid Chromatography and HPLC: Instrumentation, pumps, solvent delivery system, isocratic and gradient programming modes, sample introduction system, columns, detectors, reversed phase and normal phase chromatography. Gas Chromatography: Instrumentation, carrier gas supply, injectors, columns, packed and capillary columns, column oven and temperature programming, different detectors. Introduction to hyphenated techniques in chromatography, GC-MS and LC-MS. Diffraction Technique: Crystal geometry and structure: Introduction to lattice and lattice systems, Bragg's plane, miller indices, point groups and space groups Principle of diffraction and X-ray diffraction: X-rays production, X-ray spectra, Bragg's law and intensity of X- rays, Mosley's law, powdered XRD, percentage crystallinity, single crystal XRD, macromolecular XRD (protein crystallization, data collection and structure solution).	14

Learning Outcomes:

- To be able to use selected analytical techniques.
- Familiarity with working principals, tools and techniques of analytical techniques.
- To understand the strengths, limitations and creative use of techniques for problem-solving.

Text Books:

I. D. Campbell, Biological spectroscopy (Benjamin/Cummings Pub. Co, Menlo Park, Calif, 1984), Biophysical techniques series.

2. K. Wilson, J. M. Walker, Eds., Principles and techniques of biochemistry and molecular biology (Cambridge University Press, Cambridge, UK : New York, 7th ed., 2009).

Reference Books:

1. R. F. Boyer, Biochemistry laboratory: modern theory and techniques (Prentice Hall, Boston, 2nd ed., 2012).

2. R. Katoch, Analytical techniques in biochemistry and molecular biology (Springer, New York, 2011). 3. D. L. Spector, R. D. Goldman, Eds., Basic methods in microscopy: protocols and concepts from cells: a laboratory manual (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y, 2006).

4. J. R. Lakowicz, Principles of fluorescence spectroscopy (Springer, New York, 2006;

5. D. Harvey, Modern analytical chemistry (McGraw-Hill, Boston, 2000).

BBTC0012: GENOMICS AND PROTEOMICS

OBJECTIVES: This course provides an in-depth understanding of genomics and proteomics, focusing on their applications in the field of biotechnology. Students will explore the fundamental concepts and techniques used in the analysis of genomes and proteins, as well as their practical applications in various biotechnological processes. The course emphasizes both theoretical knowledge and practical skills through lectures, laboratory sessions, and hands-on experiments.

Credits:03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	**Introduction to Genomics:** Organization and structure of genomes, Genome size, Introns and Exons. Introduction to Proteomics – The Proteome, Bridging Genomics and Proteomics. Proteomics and the new biology. Basic principles and design of cDNA and oligonucleotide arrays, DNA microarray. Types of microarrays based on its applications: - Expression arrays, Comparative Genomic Hybridization (CGH) arrays. **Next generation sequencing:** Introduction to NGS, overview and comparison of different Sequencing Platform (Illumina, 454 (Roche), SOLiD (Life technology), Specific Biosciences, Ion Torrent, Nanopore, PacBio. Types of NGS: DNA-sequencing (Whole genome sequencing), exome sequencing, Deep sequencing, ChIP sequencing, miRNAs, lncRNAs, RNAsequencing.	24
II	**Introduction to Proteomics:** What is proteomics; Proteome complexity. Principles of protein structure (Primary, Secondary, Tertiary and Quaternary), dihedral angles (ψ and φ), Ramachandran Plot. Studying the Proteome: separation of proteins using 2D Gel, identification of individual protein using MALDI-TOF, Western Blotting, Yeast two hybrid system. **Genome Projects:** Human Genome Projects, 1000 Genome Project, 10000 Genome Project, Human Pangenome Project. **Application of Genomics & Proteomics:** Pharmacogenomics: Genomic medicine and personalized genomics Biomarker discovery and diagnostics, Metagenomics, epigenomics	24

Text Book:

1. Robert Weaver, Molecular Biology, 5th Edition, McGraw-Hill, 2012.

2. Genomes, by T.A. Brown, Garland Science, 3rd Edition, 2006

3. Anthony J.F. Griffiths, Susan R. Wessler, Richard C. Lewontin, William M. Gelbart, David T. Suzuki, Jeffrey H. Miller, An Introduction to Genetic Analysis, Eleventh Edition

4. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006) Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.

REFERENCE BOOKS:

- Introduction to Genomics. Arthur Lesk. Oxford University Press
- Brown TA, Genomes by Garland Science.

- Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics by Benjamin Cummings.
- Primrose S & Twyman R, Principles of Gene Manipulation and Genomics by Blackwell.
- Glick BR & Pasternak JJ, Molecular Biotechnology by ASM Press.
- Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
- Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cumming

Course Outcome: After completing this course, student will be able to

CO1: To comprehend the fundamental principles of genomics and proteomics.

CO2: To understand the technologies and methodologies employed in genomics and proteomics research.

CO3: To explore the applications of genomics and proteomics in understanding human diseases.

CO4: To develop critical thinking and problem-solving abilities in the context of genomics and proteomics in human welfare, health and disease.

CO5: Suggesting and outlining solution to theoretical and experimental problems in Genomics, Transcriptomics and Proteomics fields.

CO6: To have extensive knowledge of various methodologies of next generation sequencing and Mass spectroscopic, and microarray technologies.

CO7: To have crucial concepts and techniques applied in genomics, transcriptomics and proteomics.

BBTE 0001 : COMPUTER AIDED DRUG DESIGN

OBJECTIVES: To provide detailed knowledge of rational drug design process and various techniques used to develop new drug like molecules. Computer aided drug design can speed up the process, and predict the properties, thereby reduce the cost of R&D. The course will cover structure and target based design, molecular modeling, quantum mechanics, drug likeness properties, QSAR and pharmacokinetic and dynamics using several in-silico tools.

Credits: 03 **L-T-P-J: 3-0-0-0**

Module No.	Content	Teaching Hours
I	Introduction to computer aided drug designing: Stages of drug discovery and development, Rational approaches to lead discovery and analog based drug design, Reductionist target-based approach, Target identification and validation: Active site/ Pocket identification, Ramachandran plot assessment, lead identification: High through- put screening, lead optimization and prioritization: ADME-TOX screening. Ligand Based Drug Design: Virtual Screening techniques- Drug likeness screening, Concept of pharmacophore modelling, Bioisosterism pharmacokinetics. Quantitative Structure Activity Relationship (QSAR) analysis: History and development of QSAR, Classical and 3D-QSAR approaches including COMFA and COMSIA.	24
II	Structure based Drug Design: Molecular modeling- Introduction to molecular mechanics and quantum mechanics. Energy minimization methods and conformational analysis, homology modeling, molecular docking, chemoinformatics. Process of Drug Development: considerations and strategies, cost estimates, factors for choosing candidates for drug development, preclinical studies (cell-based and animal studies), clinical studies. Significance and limitations of CADD in drug discovery and development.	24

Text Book:

- Bioinformatics, second edition M.M. Ranga
- Textbook of Drug Design and Discovery, Edited byKristian Stromgaard, et al. 5th Edition.
- Computer-Aided Drug Design and Delivery Systems. 1st ed. New York: McGraw-Hill.

Reference Books:

- Blass, B. ed., 2021. Basic Principles of Drug Discovery and Development.
- Singh, D.B. ed., 2020. Computer-aided drug design. Singapore: Springer.
- Roy, K. ed., 2019. In silico drug design: repurposing techniques and methodologies. Academic Press.
- Voit, E. 2012. A First Course in Systems Biology. Garland Science.

Course Outcome : After completing this course, student will able to

CO1- Compare and understand common natural sources of drugs and contemporary approaches to drug design and development.

CO2- Demonstrate an understanding of the timelines and resources required to discover and develop new drugs in a preclinical setting.

CO3- Demonstrate an understanding of in-silico methods of pharmaceutical and medicinal chemistry in drug design.

CO4- Demonstrate an understanding of population, gender and ethnic differences in drug action, metabolism and resistance.

CO5- Apply basic techniques for drug delivery system in the body to safely achieve its desired therapeutic effect and commercialization of research during pandemics

BBTC 0810: COMPUTER AIDED DRUG DESIGNING LAB

OBJECTIVES: The subject intends to provide detailed knowledge of rational drug design process used to develop new drug like molecules. The course will cover structure and target based drug design, molecular modeling, drug likeness, pharmacokinetics and dynamics using several in-silico tools.

Credits: 02

L–T–P: 0–0–3

Module No.	Content	Lab Hours
I	1. Introduction and understanding the Bioinformatics Databases (NCBI-GeneDB, ProteinDB, PubChem, Drug Bank, RCSB-PDB, ZINC) 2. Understanding file formats (sdf,mol,pdb) and 1D Line Notations (SMILES) 3. Multiple Sequence alignment using ClustalW, Muscle and MEGAX 4. Chemical Library and Pharmacophore modeling using PubChem and ChemEMBL 5. In-silico screening of ADME-Tox using SwissADME 6. Analyse the Drug Likeness using DruLiTo 1 7. Quantitative structure-activity relationship (QSAR) Modeling 8. Protein structure validation and Ramachandran plot assessment using RAMPAGE, Pdbsum, Procheck. 9. Active site/Pocket identification using MetaPocket and PyMol. 10. Molecular Docking using AutoDock Tools/ SwissDock. 11. Molecular Dynamics Simulation and Energy Minimization using GROMACS	24

COURSE OUTCOMES: The major outcomes of this course are:

Course Outcome: After completing this course, student will be able to

CO1: To gain practical skills in analyzing rational designing to develop new drug like molecules.

CO2: Practical and theoretical skills concerning different bioinformatics databases.

CO3: Ability to evaluate how these in-silico methods are best put into use during pandemics.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO3, PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1,PO2, PO3, PO6, PO7, PO8 /PSO1, PSO2

BBTC 0809: GENOMICS AND PROTEOMICS LAB

OBJECTIVES: The subject intends to provide understanding of the fundamental concepts of Chemistry with practical exposure applicable in Engineering Sciences thereby preparing the students for a rewarding career in science and technology.

Credits: 02

L–T–P: 0–0–3

Module No.	Content	Lab Hours
I	1. To learn how to design primers. 2. Understanding basic databases: • Ensembl • NCBI 3. To learn haplotype analysis and linkage disequilibrium 4. To predict possible microRNAs targeting the gene of interest. 5. To learn basic biostatics tools for genotype analysis (Chi square and Odd's Ratio) 6. Understanding the KEGG pathway 7. To determine the RNA secondary structure and its role in protein stability. 8. To analyze protein using polyacrylamide gel.	24

COURSE OUTCOMES: The major outcomes of this course are:

Course Outcome: After completing this course, student will be able to

CO1: To gain practical skills in handling and analyzing genomic and proteomic data.

CO2: Practical and theoretical skills concerning different databases.

CO3: Ability to discuss and evaluate when and how these methods are best put into use.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO3, PO5, PO7, PO8 /PSO1, PSO2
CO2	PO1,PO2, PO3, PO6, PO7, PO8 /PSO1, PSO2

BBTC 0015: BIO-ETHICS AND IPR

OBJECTIVES: The aim of this course is to learn the students about the-

- Relevance, business Impact and protection of Intellectual Property.
- Importance of IPR.
- Process involved in patenting and claims.
- Requirements of disclosure and patent litigation.

Credits: 03

L–T–P: 3–0–0

Module No.	Content	Teaching Hours
I	**IPR :** Introduction to IPR, History of IPR in India. Essential elements of IPR- Trade secret, Patent, Copyright, Trademark. International harmonization of patent laws – WTO, GATT, TRIPs, WIPO. India and TRIPs, Protection of biotechnological inventions, IPR and developing countries, Broad patents in biotechnology, Choice of IPR protection, Management of IPR , Benefits and problems from IPR, Indian response to IPR upheaval. Infringement of patents - Flavr Savr™ tomato as a model case. Biopiracy and case studies on patents (Basmati rice, Turmeric, and Neem).	12
II	**Biosafety-** Introduction. Different levels of biosafety– BL1, BL2, BL3 and BL4. Biosafety guidelines in India. Guidelines for rDNA research activities, Good Laboratory Practices (GLP). Containment- Physical containment, Biological containment. **Bioethics-** Bioethics in Biodiversity Resource management – Definition, Ethical issues of biodiversity. Ethical issues in genetically modified organisms- Introduction, History of genetic modification, Techniques of genetic modification, Uses of genetic modification. Genetically modified food, Health implications of genetically modified food, Public health principles regarding the regulation of genetically modified food. Labeling of genetically modified food products. Benefits of labeling, Guidelines for labeling of genetically modified agricultural products. Animal cloning and their ethical aspects.	12

Text Book:

- Bioethics and Biosafety, M.K.Sateesh, I.K.International Pvt. Ltd,New Delhi, India.

Reference Books:

- Molecular Biotechnology, Second Edition, Glick, B.R., and Pasternack, J.J., ASM Press, Washington, DC.
- Introduction to Plant Biotechnology, H.S.Chawla, Oxford & IBH Publishing Co. Pvt. Ltd.

COURSE OUTCOMES: After completion of course, the student will be able to:

CO1- Uptake challenging problems associated with patenting, intellectual property rights.
CO2-Understand to complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works
CO3- During their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search. This provide further way for developing their idea or innovations
. CO4- Understand the importance of the intellectual property rights in practical life.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO2, PO3, PO5, PO8/PSO2, PSO3
CO2	PO1, PO2, PO4/PSO1, PSO3
CO3	PO6, PO7,PO8/PSO2

BBTC : ENVIRONMENTAL ENGINEERING

OBJECTIVES: The aim of this course is to learn the students about the-
Environmental studies and sustainable development by using the bioremediation and Pollution control .

Credits: 03 **L–T–P: 3–0–0**

Module No.	Content	Teaching Hours
I	Basic ideas of environment, Mathematics of population growth and associated problems, Environmental degradation: Acid rain, toxic element, particulates, noise pollution, air pollution and its effect on man. Overall methods for pollution prevention, environmental problems and sustainable development, components of environment Ecological balance and consequence of change: Effect of abiotic factor on population, flow chart of different cycles with only elementary reaction [oxygen, nitrogen, phosphate, sulphur], food chain [definition and one example of each food chain). Sources & effect of different air pollutants, smog-photochemical smog, depletion of ozone layer, green house gas & global warming, Basis of ecology, ecosystem and biosphere, ecological components (Biotic and abiotic); Interdependence of life forms, examples of cohabitation of organisms, symbiosis and parasitism, concepts of food webs, Biodiversity, Bioterrorism.	12
II	Engineering Systems for air pollution control- basic concepts of control mechanisms, devices and their design; Engineering Systems for water pollution control- basic concepts of control mechanisms, devices and their design; primary, secondary and tertiary treatment process, natural purification system. General knowledge of laws, regulations and rules concerning air, water, soil and noise pollution. Familiarity with Environmental protection act. Environmental impact assessment. Bioremediation Techniques.	12

Text Books:

1. C.S Rao, Environmental pollution and control Engeering
2. A K Dey, Environmental chemistry
3. Concepts in Biology By E.D.Enger & F.C.Ross, 9th Ed Tata McGraw Hill

Reference Book:

1. B S Chauhan Environmental pollution
2. Biology by P.H.Raven et.al, 5th Ed. WBC McGraw Hill

COURSE OUTCOMES: After completion of course, the student will be able to:

CO1- Uptake challenging problems associated with Pollution and types of pollution.
CO2-Understand the effects of environmental degradation.
CO3- Understand the global warming, ecological components (Biotic and abiotic), symbiosis and parasitism, concepts of food webs, Biodiversity and Bioterrorism.
. CO4- Understand the importance of Bioremediation.