

**DEPARTMENT OF BIOTECHNOLOGY***DELHI TECHNOLOGICAL UNIVERSITY: DELHI*

Established under Govt. of Delhi Act 6 of 2009

Shahbad Daultapur, Bawana Road, Delhi-110042

**Scheme and Syllabus (BTech 1<sup>st</sup> year)**

<b>First Semester</b>				
<b>S. No.</b>	<b>Subject Code</b>	<b>Subject</b>	<b>Credits</b>	<b>Category</b>
1.	AM101	Mathematics-I	4	BSC
2.		Physics/Programming Fundamentals	4	BSC/ESC
3.	AC101	Interdisciplinary Core Course-1*Applied Chemistry (AC)	4	BSC/ESC
4.	EC101	Interdisciplinary Core Course-2* (Basic Electronics and Communication Engineering (BEC)	4	BSC/ESC
5.	BT103	Skill Enhancement Course-1 (Applied Aquaculture)	2	SEC
6.	AEC/VAC	Ability Enhancement Course-1 NAC-1	2.	AEC
Total			20	
<b>Second Semester</b>				
		<b>Subject</b>	<b>Credits</b>	<b>Category</b>
1.	AM102	Mathematics-I!	4	BSC
2.	C0102	Programming Fundamentals/Physics	4	ESC/BSC
3.	BT102	Interdisciplinary Core Course-3# (Biochemical Engineering Principles)	4	BSC/ESC
4.	BT104	Departmental core Course1 (Introduction to Biotechnology)	4	BSC/ESC
5.	BT106	Skill Enhancement Course (SEC)-2 (Development of Scientific Instrumentations and its applications	2	SEC
6.	AEC/VAC	Ability Enhancement Course-2NAC-2	2	AEC
Total			20	

## First Semester

### Details of course: - Skill Enhancement Course-1 (Applied Aquaculture) BT 103

Course Title	Course Structure			Pre-Requisite
Applied Aquaculture (BT 103)	L: 1	T: 0	P: 2	Nil

#### Course Objective:

- To give first-hand training on various aspects of Aquaculture.
- To enhance quality aqua crops production.
- Skilled manpower development.
- Employment generation.

#### Course Outcome:

I.	Gain working knowledge of economically aquatic organisms.
II.	Acquire skills for setting up an aquarium and cultivating ornamental fishes.
III.	Understand the role of fishes in the environmental management.
IV.	Well versed in technology-based aquaculture systems like recirculating aquaculture systems, aquaponics systems, and advances in seed production and feed production processes.

S.NO	Detail Contents	Contact Hrs.
1	<b>Introduction to Aquaculture:</b> Designing (layout) and drawing of a self-sustainable Aquaculture farm, Identification of cultivable finfishes and shellfishes and drawing of their pictures, Collection, and identification of various freshwater aquatic plants, Understanding of the role of different aquatic plants in aquaculture, Identification of harmful aquatic insects and their remedial measures, Identification of various phytoplankton and zooplankton.	3
2	<b>Recirculating Aquaculture System (RAS) and water Quality management:</b> Designing of a Recirculating Aquaculture System (RAS) and understanding of functions of its various parts in the maintenance of water quality. Designing of an Aquaponics System and its role in the sustainable aquaculture development. Fish Breeding, Construction of a fish aquarium, Maintenance of one Aquarium with fish during the Course tenure, Value addition in aquacrops and their preservation. Study of major water quality parameters viz., temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity, and ammonia in a fish culture pond.	3
3	<b>Live Feed Culture and Feed Formulation:</b> Culture of live food organisms, Culture of any fish larvae and their feeding, Selection of non-conventional ingredients for the formulation of fish feed, the study of biochemical composition (protein, lipid, carbohydrates, ash) contents of the ingredients, Formulation of fish feed using locally available ingredients, feeding techniques: hand feeding, bag feeding, demand feeding etc.,	3
4	<b>Aquaculture Site Visit:</b> Visits to the local Fish market to get exposure to the various fishes, visit to a fish farm, Exposure to advanced aquacultural systems, viz. Recirculating Aquaculture System, Aquaponics System, visit to Pearl culture facility, visit to a National Institute, Visit to a fish processing industry.	3

<b>5</b>	<b>Aquaculture in Practice:</b> First hand working experience with fish (minimum 15 days) in a fish farm/institute/laboratory, Preparation of a project proposal in any area of aquaculture for financial support.	2
<b>Total</b>		14

**Books:**

S. No.	Name of Books / Authors/ Publishers
1	AOAC, Association of Official Analytical Chemists. 2000. Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists Inc.
2	APHA, American Public Health Association. 2012. Standard Methods for the Examination of Water and Waste Water. 22 nd ed. Washington DC: American Public Health Association, American Water Works Association, Water Environment Federation.
3.	Pillay, T. V. R. 2005. Aquaculture. Principles and Practices. Blackwell Publishing, New Delhi, India.
4.	Chakrabarti, R. and Sharma, J. G. 2008. Aquahouse. New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.
5	Holt, G. J. 2021. Larval Fish Nutrition. Willey-Blackwell, UK.

## Second Semester

### Details of course: - Biochemical Engineering Principles Interdisciplinary course 3 (BT 102)

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Biochemical Engineering Principles (BT 102)	3	1	0	Nil

Course Objective: To introduce the key aspects associated with biochemical processes and calculation techniques used in reactor designing and to acquaint the students with fundamentals of the different reaction systems.

#### Course Outcome (CO):

1. Understand the Microbial Process Principles such as Microbial growth curve and biomass yield. Compare and Contrast the Energetics of the cells.
2. Analyse the Mathematical modelling and kinetics of microbial growth such as Substrate utilization, Product formation and Plasmid Instability.
3. Identify the Sterilization Principles and mechanism of media, air sterilization along with thermal death kinetics of microorganism.
4. Distinguish the different types of Bioreactor, its design and working conditions, and understand the homogeneous and heterogeneous reaction system.
5. Understand the Instrumentation and Control of Biochemical process variables, their measurements, control principles and their application in bioreactors.

S.No	Content	Contact Hours
Unit 1	Microbial Process Principles: Microbial growth; Synchronous culture, Biomass yield; Energetics of the cells.	8
Unit 2	Kinetics of Microbial Growth, Substrate Utilization and Product Formation: Mathematical modelling of microbial growth; Substrate utilization and product formation kinetics; plasmid Instability.	9
Unit 3	Sterilization: Principles and mechanism of media sterilization. Thermal death kinetics, Air sterilization.	8
Unit 4	Bioreactor Design and Analysis: Bioreactor configuration, Bioreactor design and optimum operations, Basic concept of scale-up of bioreactors, Introduction to design of homogeneous & heterogeneous reaction system.	9
Unit 5	Instrumentation and Control: Biochemical process variables and their measurements, Control principles and their application in bioreactors.	8
Total		42

Books: -

S.No.	Name of Books/Authors/Publisher
1.	Introduction to Biochemical Engineering by D.G. Rao. Publisher: Tata McGraw-Hill Education, 2009
2.	Bioprocess Engineering Principles by P. Doran, Elsevier Science, 2013
3.	Principles of fermentation technology by Stanbury and Whitaker, Elsevier Science, 2016
4.	Chemical reaction engineering by O.Levenspiel. Publisher: John Wiley and sons Inc., 1999
5.	Coulson's and Richardson's Chemical Engineering by J.F. Richardson and D.G. Peacock Publisher: Asian books, 1994

**Details of course:- Departmental core Course1 (Introduction to Biotechnology) (BT 104)**

Course Title	Course Structure			Pre-requisite
	L	T	P	
<b>Introduction to Biotechnology (BT 104)</b>	3	1	0	Nil

**Course Objective:** The course integrates the fundamental concepts of life and physical sciences together with the basic laboratory skills necessary in the biological sciences. It provides foundational concepts in a broad spectrum of disciplines such as biochemistry, genetic engineering, biophysics, microbiology, molecular and cell biology

**Course Outcomes (CO):**

1. Define global significance of biotechnology and examine the potential applications of Biotechnology in all sectors of life
2. Compare and contrast prokaryotic and eukaryotic cellular architecture
3. Comprehend the functioning of various biomolecules and enzymes and to compare and contrast various microorganisms
4. Explain the underlying mechanism of gene expression and to explain, demonstrate, and appraise genetic engineering of organisms for human welfare and formulate new ideas
5. Explain and translate separation, purification and identification techniques for biomolecules in research

S. No.	Content	Contact Hours
<b>Unit 1</b>	<b>Introduction:</b> Definition, scope of Biotechnology; Applications of Biotechnology in Agriculture, Health, Food, Environment and Industry	<b>8</b>
<b>Unit 2</b>	<b>Cell Structure:</b> Architecture of prokaryotic and eukaryotic cells; Functions of various cell organelles; Cell motility	<b>9</b>

<b>Unit 3</b>	<b>Fundamentals of Biochemistry and Microbiology:</b> Classification and functions of carbohydrates, proteins, lipids, nucleic acids; General characteristics, nomenclature and classification of enzymes; Types and characteristics of microbes	<b>7</b>
<b>Unit 4</b>	<b>Basic Concepts of Molecular Biology and Genetic Engineering:</b> Structure of DNA and RNA; Gene organization; Central Dogma of Molecular Biology; Concept of recombinant DNA technology	<b>10</b>
<b>Unit 5</b>	<b>Basics of Biophysical Methods:</b> Electrophoresis, Centrifugation, Chromatography - Principle, procedure and applications	<b>8</b>
	<b>Total</b>	<b>42</b>

**Books:**

<b>S. No.</b>	<b>Name of Authors /Books / Publishers</b>
1.	Lehninger's Principle of Biochemistry by Nelson and Cox. Publisher: W. H. Freeman (2017)
2.	Cell and Molecular Biology by Jacobs. Publisher: CBS (2016)
3.	Cell and Molecular Biology by P. Khanna. Publisher: IK Intl. (2008)
4.	Molecular Cell Biology by Lodish. Publisher: W. H. Freeman (2016)
5.	Biochemistry by Voet and Voet. Publisher: Wiley (2010)
6.	Microbiology by Pelczar et al. Publisher: Tata McGraw Hill (2001)
7.	Microbiology by Tortora et al. Publisher: Pearson Education (2016)
8.	Molecular Biology of the Gene by Watson et al. Publisher: Pearson (2014)
9.	Gene Cloning & DNA Analysis: An Introduction by TA Brown. Publisher: Wiley-Blackwell (2016)
10.	Genetic Engineering by Rastogi and Pathak. Publisher: OUP (2009)
11.	Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Hoffman and Clokie (ed.) Publisher: CUP (2018)

**Details of course: Skill Enhancement Course (SEC)-2 (Development of Scientific Instrumentations and its applications (BT 106))**

Course Title	Course structure			Pre-requisite
	L	T	P	
Development of Scientific Instrumentations and its applications (BT 106)	1	0	2	Basic Instrumentations

**Course Objective:**

To impart broad knowledge of commonly used instruments and their working principles, in development of new scientific instrumentation and medical devices

**Course outcome (CO)**

1. To impart the knowledge about various basic instruments and its type and applications in diagnostics and scientific investigation.
2. To master the electrophoresis techniques in separation and analysis of Macromolecules (DNA, RNA and proteins) and their fragments, based on their size and charge.
3. To master the chromatographic techniques and application of methods in biotechnology, pharmacy, diagnostics, therapy and scientific investigation.
4. To master the MEMS technology and application of biomedical device development.
5. Understanding of Sensing technology and development of biosensors for medical diagnostics.

S. No.	Content	Contact Hours
Unit 1	<b>Basic Instrumentation:</b> <b>Optical Techniques: Microscopy:</b> Optical and Electron Microscopy, Fluorescence microscopy <b>Hydrodynamic Techniques: Centrifugation:</b> Viscosity and diffusion, Analytical and Preparative centrifuges <b>Spectroscopic:</b> UV and visible, spectrofluorimetry	3
Unit 2	<b>Advanced Instrumentation:</b> <b>Electrophoretic Techniques:</b> Paper and gel electrophoresis, Immuno electrophoresis,	2
Unit 3	<b>Chromatographic Methods:</b> Paper, TLC gas chromatography, gel filtration	2
Unit 4	<b>Medical device design and development:</b> Introduction to MEMS, Materials used- Technology involved in MEMS, MEMS <b>Application in Medicine</b> (BioMEMS): Special features / requirements for medical applications. Current scenario of MEMS for health care.	3
Unit 5	<b>Biosensors:</b> Sensors and transducers; Chemistry of biomolecules and their immobilization for biosensors, Types of biosensors and their application -Environmental monitoring, process control, and clinical/biochemical analysis, Immunosensors.	4
Total		14

## Books

S. No.	Name of Book/Author/Publisher
1	Principles and Techniques of Practical Biochemistry by Keith Wilson and John Walker, Fifth edition, Cambridge University Press
2	Biophysical Chemistry: The conformation of Biological Macromolecules by C.R.Cantor and P.R. Schimmel. Publisher: W.H. Freeman
3	Introduction to Spectroscopy by D.L. Pavia, G.M. Lampman and G. S. Kriz.and Vyvyan Publisher: Brooks Cole
4	MEMS & Microsystem, Design and manufacture by Tai-Ran Hsu , McGraw Hill.
5	Biosensors: An Introductory Textbook by Jagriti Narang, C.S. Pundir- <a href="#">Jenny Stanford Publishing</a>

## Lab Course

### BT 000 :Lab based on Development of Scientific Instrumentations and its applications

Experiment No.	Name of Experiment
1	To demonstrate the functioning of Microscope.
2	To demonstrate the working of Centrifugation - low speed and high speed.
3	Spectrophotometric techniques- Determination of Protein concentration using Lowry's method
4	To demonstrate Chromatography techniques in biomolecular separations, ion exchange, gel filtration and affinity columns
5	To demonstrate the working of Thin Layer Chromatography in pigment separation
6	To demonstrate the Cell disruption techniques for biomedical diagnostics
7	To demonstrate the Electrophoresis techniques – 1D and 2D.
8	To demonstrate the functioning of Ph Meter
9	To demonstrate the Photolithography techniques
10	To demonstrate the functioning of Micro array, Biochip and microfluidic devices

## Books:

S. No.	Name of Book/Author/Publisher
1	Principles and Techniques of Practical Biochemistry by Keith Wilson and John Walker, Fifth edition, Cambridge University Press
2	MEMS & Microsystem, Design and manufacture by Tai-Ran Hsu , McGraw Hill.
3	Biosensors: An Introductory Textbook by Jagriti Narang, C.S. Pundir- <a href="#">Jenny Stanford Publishing</a> .

## Scheme and syllabus (BTech 2<sup>nd</sup> year)

### Third Semester

S.No.	Subject code	Subject	Credits	Category
1.	BT201	Applied mathematics (Interdisciplinary engineering science course -1)	4	ESC
2.	BT203	Cell Biology (Department core course-2)	4	DCC
3.	BT205	Genetics (Department core course-3)	4	DCC
4.	BT207	Fundamentals of computational biology (Department core course-4)	4	DCC
5.	BT209	Bioprocess Technology and Downstream Processing (Department core course-5)	4	DCC
6.	AEC/VAC	Value Addition course -1	2	VAC
7.	MS299	Community Engagement Course	2	Mandatory
		Total	24	

### Fourth Semester

S.No.	Subject code	Subject	Credits	Category
1.	BT204	Data Structure and Algorithm (Interdisciplinary core course-2)	4	ESC
2.	BT202	Molecular Biology (Department core Course-6)	4	DCC
3.	BT206	Microbiology (Department core Course-7)	4	DCC
4.	BT208	Advances in computational biology (Department Core Course-8)	4	DCC
5.	BT210	Biochemistry (Department Core Course-9)	4	DCC
6.	AEC/VAC	Value addition course -2	2	VAC
		Total	22	

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Applied Mathematics (BT 201)	3	1	0	

Course Objective: Learning mathematical tools applicable in Biotechnology

**Course Outcome (CO):**

- 1 Analyse and measure the central tendency, dispersion. Moments, Skewness, and Kurtosis, Multiplication rule of probability along with Baye's rule.
- 2 Illustrate the Mathematical expectation and Statistical parameters as well as the Moment generating function.
- 3 Identify the Probability Distributions and its type.
- 4 Analyse the Solution of Algebraic and Transcendental Equations of Bisection method.
- 5 Organize the System of Linear Algebraic Equations such as Gauss elimination method, Crout's method.

S.No.	Content	Contact Hours
Unit 1	Descriptive Statistics & Probability: Graphical methods for data. representation. Measure of central tendency. Measure of dispersion. Moments, Skewness, and Kurtosis. Mathematical and Statistical concepts. Axiomatic concepts. Addition rule of probability. Conditional probability. Multiplication rule of probability. Baye's rule.	8
Unit 2	Random variable and Expectation: random variable and distribution function. Jointly distributed random variables. Mathematical expectation. Statistical parameters. Moment generating function.	8
Unit 3	Probability Distributions: Binomial distribution. Geometric distribution. Poisson distribution. Normal distribution. Normal distribution as limiting case of Binomial distribution. Exponential distribution.	10
Unit 4	Solution of Algebraic and Transcendental Equations: Bisection method, Regula Falsi method, Secant methods, Newton-Raphson method, Fixed-point iteration method.	8
Unit 5	System of Linear Algebraic Equations: Gauss elimination method, Crout's method, Gauss-Seidel and Gauss Jacobi methods.	8
Total		42

Books:-

S.No.	Name of Books/ Author/Publisher
1	Probability and Statistics for Engineers and Scientists by Ross, S.M., 3rd ed. Publisher: Academic Press, (2005).
2	Numerical Methods for Scientific and Engg... Computations: M.K.Jain, S.R.K. lyenger and R.K. Jain., New Age International (1993)
3	Advanced Engineering Mathematics, Erwin Kreyszig, 10th, 2010, Wiley edition

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Cell Biology (BT 203 )	3	1	0	Knowledge of biomolecules

Course Objective: To impart basic knowledge of cell and its mechanistic features for better understanding of other subjects.

Course Outcome:

1. To compare and contrast prokaryotic and eukaryotic cellular architecture and understand the mechanisms behind cell motility
2. To explain the underlying mechanism of cell cycle, cell division and programmed cell death.
3. To comprehend cell communication mechanisms
4. To understand the process of protein targeting to various organelles
5. To get insight into the causes of cancer and to devise strategies for specifically targeting cancer cells

S.No.	Content	Contact Hours
Unit 1	Cell structure: Structure of prokaryotic and eukaryotic cells; Functions of various organelles; Cytoskeletal elements	9
Unit 2	Cell Cycle and Cell Division: Molecular events in cell cycle; Regulators of cell cycle; Control of mitosis and meiosis; Apoptosis: Mechanism; Roles of Bcl family of proteins, caspases and cytochrome c	8
Unit 3	Cell-Cell interactions: Cell junctions; Cell adhesion molecules; Extracellular matrix; Signal transduction: Types of signaling; Signals and Receptors; Secondary messengers; Intracellular signaling proteins; Signaling through cell surface receptors	9
Unit 4	Protein sorting: Transport of proteins to various organelles; Secretory pathway; Vesicular trafficking; Transport across membranes; Receptor mediated endocytosis	8

Unit 5	Cancer: General concepts; Targeted therapies; Roles of protooncogenes and tumor suppressor genes; pRb and p53	8
Total		42

Books:-

S.No.	Name of Books/ Author/Publisher
1.	Cell and Molecular Biology by P Khanna. Publisher: IK Intl.
2.	Karp's Cell and Molecular Biology by G Karp, J Iwasa, W Marshall. Publisher: John Wiley and Sons, Inc.
3.	The Cell: A Molecular Approach by GM Cooper, RE Hausman. Publisher: Sinauer Associates Inc.
4.	Molecular Biology of the Cell by B Alberts, R Heald, A Johnson, D Morgan, M Raff, K Roberts, P Walter. Publisher: Garland Science
5.	Molecular Cell Biology by H Lodish, A Berk, CA Kaiser, M Krieger, A Bretscher. Publisher: WH Freeman

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Genetics (BT 205)	3	0	2	Nil

**Course Objective:**

Deepen the understanding of genetic principles, including advanced topics in molecular genetics, population genetics, and epigenetics.

S. No.	Content	Contact Hours
Unit 1	Introduction to Genetics: Historical Overview of genetics; Mendelian Genetics; Laws of Inheritance; Extension to Mendelian Genetics: Multiple alleles, Incomplete dominance, Codominance; Population Genetics; Genetic advancements in fields of agriculture and medicine	10
Unit 2	An overview on structure and Organization of Chromosomes: Structural overview of Chromosome; Cell cycle and Cell Division; Organization of extranuclear genomes; Chromosomal abnormalities and disorders	08
Unit 3	Quantitative inheritance and chromosomal basis of inheritance and linkage: Quantitative Traits and Heritability; The chromosomal theory of inheritance; Sex linked inheritance in humans; Mendelian vs Polygenic Inheritance; Genetic linkage and mapping	10
Unit 4	Mechanism of genetic change: Mutation and mutagenesis; DNA repair mechanism; Horizontal Gene Transfer; Chromosomal Aberration; Recombination; Gene flow and Migration, Genetic Recombination	08
Unit 5	Cytogenetics techniques: Fluorescence <i>in situ</i> hybridization; Spectral karyotyping; AFLP, RAPD, RFLP, Molecular markers	06
	Total	42

Books:

S.No.	Name of Book/Author/Publisher
1.	Principles of Genetics by E.J. Gardner, M.J. Simmons and D.P. Snustad. Publisher: John Wiley and Sons Inc.
2.	Genetics by M.W. Strickberger. Prentice Hall College Division
3.	Concepts of Genetics by W.S. Klug et al. Pearson Education Inc
4.	Principles of Genetics by S. Snustad and M.J. Summons. John Wiley & Sons Inc.

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Fundamentals of computational biology (BT 207)	3	0	2	

Course Objective: The objective of the course is to introduce students to the current bioinformatics algorithm concepts and their implementation

**Course Outcome (CO):**

- 1 Explain mathematical concepts involved in biology.
- 2 Gain basic knowledge of modern molecular biology and genomics
- 3 Develop an algorithm for analysis of biological sequences.
- 4 Apply molecular methods to study genetic variation within and between species
- 5 Explain and evaluate different phylogenetic optimal criteria.
- 6 Choose systems biology tools that will help in reconstructing and redefining complex biological processes.

S.No.	Content	Contact Hours
Unit 1	Introduction to Biological Databases: Types, Overview of Biological Databases and Retrieve Nucleic acid databases: NCBI: Pubmed, Entrez, Blast, OMIM, Books, Taxonomy, Structure, Locuslink. Protein Databases- Primary, secondary & Composite, databases Structural classification database, Sequence Formats & storage, Sequence submission to sequence Database.	8
Unit 2	Genomics: Structure of DNA, Polymorphisms in DNA Sequence, Human Genome Project, Complete Genome Sequences, Functional Annotation	8
Unit 3	Data analysis in Bioinformatics: Visualize and explore genomic data using genome browser, explore webbased platforms for data intensive biomedical research	8
Unit 4	Pairwise Sequence Alignment: Local alignment, Global alignment, Scoring matrices- PAM, BLOSUM, Gaps, Dot Plots. Dynamic programming Approach: Needleman and Wunsch Algorithm, Smith and waterman Algorithm, Heuristic Approach: BLAST, FASTA.	9
Unit 5	Multiple Sequence Alignment: global and local alignments, scoring matrices and gap penalties, filtering, position specific scoring matrices, internet resources, uses of multiple sequence alignment, programs and methods for multiple sequence alignment, representation, structural inference.	9
Total		42

**Books:-**

S.No.	Name of Books/ Author/Publisher
1.	All About Bioinformatics: From Beginner to Expert- Yasha Hasija (2023)
2.	Hands on Data Science for Biologists Using Python- Yasha Hasija, Rajkumar Chakraborty (2021).
3.	Beginners Guide To Bioinformatics For High Throughput Sequencing- Tin Wee Tan, Eric Cheng-yu Lee (2018).
4.	Translational Biotechnology-A Journey from Laboratory to Clinics- Editor: Yasha Hasija (2021)
5.	Essentials of Bioinformatics, Volume II, In silico life science: medicine- Shaik (2019)

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Bioprocess Technology and downstream processing (BT 209)	3	0	2	

**Course Objective:**

Introduction of bioprocess technology necessitates innovation in process development scale-up and design. An integral and cost intensive part of these processes is associated with downstream processing for product isolation and purification.

**Course Outcome (CO):**

- 1 Distinguish between bioprocessing vs. chemical processing. Understand the basics of cell culture techniques, media design and inoculum development and aseptic transfer methods.
- 2 Compare and contrast primary and secondary metabolite, their process technology and extraction of metabolites from plant and animal cell culture.
- 3 Apply the knowledge for understanding an industrial set up to produce products such as microbial enzymes, biomass, biofertilizers and biopesticides.
- 4 To gain knowledge about characteristics of bio products, cell disruption methods and mechanical methods of separation.
- 5 To gain insight to the working of downstream processes at an industrial scale.

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S.No.	Content	Contact Hours
Unit 1	Bioprocess vs. chemical processing; substrate for bioconversion process and design media. Cell culture techniques: isolation methods, media design and sterilization ; Inoculum development and aseptic transfer : criteria for inoculum transfer, aseptic inoculation	8
Unit 2	Process technology for production of primary metabolites - Baker's yeast, ethanol, acetone-butanol , citric acid, amino acids, polysaccharides and petides and plastics; Production of secondary metabolites - Penicillin , cephalosporins, streptomycin etc. metabolites from plant and animal cell culture.	9
Unit 3	Microbial production of industrial enzymes such as glucose-isomerase, penicillin acylase, cellulase, amylase, lipase, protease etc.; Biomass (mushroom) production from agro-residues; Biofertilizers and Biopesticides.	8
Unit 4	Characteristic of bioproducts; Cell disruption methods; Mechanical methods of separation Flocculation and conditioning of broth. Sedimentation, Filtration and centrifugation – principle, instrumentation, types and application	8
Unit 5	Solid liquid separation- Protein precipitation and its separation; aqueous two phase extraction - principle, instrumentation and applications; adsorption- desorption processes; Membrane based separation; Dialysis, Electrodialysis, Microfiltration, Ultrafiltration, electrophoresis.Chromatographic methods of separation based on size, charge, hydrophobic interaction and biological affinity; Crystallization and drying.	9
Total		42

Books:-

S.No.	Name of Books/ Author/Publisher
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1	Industrial Microbiology: An Introduction by Michael J. Waites, Wiley-Blackwell (2009)
2	Principles of fermentation technology by Stanbury and Whitaker, Elsevier Science (2016)
3	Introduction to Biochemical Engineering by D.G. Rao, McGraw Hill education (2009)
4	Bioprocess Engineering Principles by P. Doran, Elsevier Science (2013)

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Data structure and algorithm (BT 204)	3	0	2	

**Course Objective:**

The course aims to introduce a no. of popular data structures and algorithm, along with the basic technique in algorithm analysis.

**Course Outcome (CO)**

1. Understand basic data structures such as arrays, strings. Study linear data structures such as stacks and queues and understand their difference
2. Understand need of dynamic memory allocation, study different types of linked list linked list
3. Study tree, various operations on binary search tree, Application of binary search tree
4. Study different techniques for solving problems like sorting and searching. Describe the hash function and concepts of collision and its resolution methods.
5. .Study graph, and various operations on that and their application

S.No.	Content	Contact Hours
Unit 1	Introduction: Introduction to Algorithmic, Complexity- Time-Space Trade off. Introduction to abstract data types, design, implementation and applications. Introduction to List data structure. Arrays and Strings: Representation of Arrays in Memory: one dimensional, Twodimensional and Multidimensional, Accessing of elements of array, performing operations like Insertion, Deletion and Searching. Sorting elements of arrays. Strings and String Operations. Stacks and Queues: Introduction to data structures like Stacks and Queues. Operations on Stacks and Queues, Array representation of Stacks , Applications of Stacks : recursion, Polish expression and their compilation conversion of infix expression to prefix and postfix expression, Operations of Queues, Representations of Queues Applications of Queues, Priority que	9
Unit 2	Linked Lists: Singly linked lists, Representation of linked list, Operations of Linked list such as Traversing, Insertion and Deletion, Searching, Applications of Linked List. Concepts of Circular linked list and Doubly linked list and their Applications. Stacks and Queues as linked list.	8

Unit 3	Trees: Basic Terminology, Binary Trees and their representation, binary search trees, various operations on Binary search trees like traversing, searching, Insertion and Deletion, Applications of Binary search Trees, Complete Binary trees, Extended binary trees. General trees, AVL trees, Threaded trees, B- trees.	8
Unit 4	Sorting: Insertion Sort, Quick sort, Merge sort, Heap sort, sorting on different keys, External sorting. File Structure: File Organization, Indexing & Hashing, Hashing Functions, Collision Resolution Techniques	9
Unit 5	Graphs: Terminology and Representations, Graphs & Multi-graphs, Directed Graphs, Representation of graphs and their Transversal, Spanning trees, shortest path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths.	6
Total		42

**Books:-**

1.	Ellis Horowitz and Sartaz Sahni. Fundamentals of Data structures. Galgotia Publications, New Delhi (1984).
2.	Tanenbaum, "Data Structures using C and C++", PHI (1997)
3.	Data Structures through C by Yashavant Kanetkar, Bpb publications (2008)
4.	J. Tremblay and P.G. Sorensen. "An Introduction to Data Structures and Application", McGraw Hill College Division (1998)
5.	Data Structures and Algorithms by A.V. Aho, J.E. Hopcroft and J. Ullman. Publisher: Addison-Wesley Publishing (1983)

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Molecular Biology (BT 202)	3	0	2	Knowledge of structure of nucleic acids and proteins

Course Objective: To give a detailed perspective of the Central Dogma of Molecular Biology and some basic molecular biology techniques

Course Outcome (CO):

- To know the molecular mechanism of DNA replication in both prokaryotes and eukaryotes
- To learn basic mechanism of transcription and various post-transcriptional processing events for pre-mRNA, pre-rRNA, pre-tRNA
- To gain knowledge about gene expression, the structure of ribosomes, mRNA, tRNA, rRNA, and soluble factors involved in translation
- To gain insight into the strategies for gene silencing and their application for genetic engineering purposes

5 To appraise various genetic manipulation, DNA sequencing, DNA amplification, and Nucleic acid analysis techniques

S.No.	Content	Contact Hours
Unit 1	DNA replication: Prokaryotic and eukaryotic DNA replication; Mechanism of DNA replication; Telomeres	8
Unit 2	Transcription and Post transcriptional processing of RNA: Transcription in prokaryotes and eukaryotes; Transcription factors; RNA polymerase; Regulatory elements; Post transcriptional processing of precursor mRNA, rRNA and tRNA	8
Unit 3	Translation and Post translational modifications: Genetic code; mRNA transport; Prokaryotic and eukaryotic translation; Post translational modifications of proteins	9
Unit 4	Regulation of gene expression: Concept of operon; Transcriptional and post-transcriptional gene silencing; Ubiquitination; Application of antisense RNA, RNAi, ribozyme	9
Unit 5	Techniques in Molecular Biology: DNA sequencing; Basics of PCR; Basics of DNA cloning; Southern and Northern hybridization	8
Total		42

Books:-

S.No.	Name of Books/ Author/Publisher
1.	Molecular Biology of the Gene by JD Watson et al. Publisher: Pearson
2.	Biochemistry by D Voet, JG Voet. Publisher: Wiley
3.	Lewin's Gene XII by JE Krebs, ES Goldstein, ST Kilpatrick. Publisher: Jones & Bartlett Learning
4.	Genomes 4 by TA Brown. Publisher: Garland Science
5.	Essential Molecular Biology (Practical Approach Series) by Brown. Publisher: OUP

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Microbiology (BT 206)	3	0	2	

**Course Objective:**

To impart basic knowledge of all classes of micro-organisms namely, bacteria, viruses, algae, fungi and protozoa and also methods of sterilization and culturing of microbes. The course also aims to give a broad overview of the applications of microbiology in our present world.

**Course Outcome (CO):**

- 1 Elucidating the discovery of the microbial world and illustrating the methods of microbial culture and enrichment techniques. and analyzing characteristics of viruses
- 2 Demonstrate the Prokaryotic Structure and Function. Understand the methods of controlling undesirable microorganisms and Bacterial Inactivation kinetics.
- 3 Summarize Microbial Nutrition and Growth, mathematical expression of growth, Analyze culture for the utilization of Biomass yield.
- 4 Demonstrate the Microbial Taxonomy, nomenclature and Bergey's manual
- 5 Compare and contrast Host-Pathogen interactions; Pathogenicity islands and their role in bacterial virulence

S.No.	Content	Contact Hours
Unit 1	Introduction and Methods in Microbiology: Discovery of the microbial world, controversy over spontaneous generation, principles of microbial nutrition, Culture media, Theory and practice of sterilization, pure culture techniques, Enrichment culture techniques for isolation of different microorganism, culture collection and maintenance of cultures..	8
Unit 2	Prokaryotic Structure and Function: functional anatomy of bacteria: cell envelope, cell wall, cytoplasmic membrane, capsule, surface appendages, cytoplasm and cytoplasmic inclusions. Methods of Controlling Undesirable Microorganisms, Disinfectant Decay and Bacterial Inactivation kinetics	8
Unit 3	Microbial Nutrition and Growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen, Chemolithotrophy; nitrate and sulfate reduction; methanogenesis and acetogenesis. Fermentations diversity, syntrophy, role of anoxic decompositions. Nitrogen metabolism; nitrogen fixation; antimicrobial agents, sulfa drugs, antibiotics – penicillins and cephalosporins, broad spectrum antibiotics.	9
Unit 4	Microbial Taxonomy: New approaches to bacterial taxonomy, classification including ribotyping, ribosomal RNA sequencing, characteristics of primary domains, taxonomy, nomenclature and Bergey's manual	8
Unit 5	Host-parasite Relationship: Normal microflora of skin, oral cavity, gastrointestinal tract; entry of pathogens into the host, colonization factors predisposing to infections, types of toxins (exo-, endo-, entero-)	9

	and their structure, mode of actions, vigilance and pathogenesis. Plant – Microbe Interactions Microbial Pathogenesis: Disease reservoirs; Epidemiological terminologies; Infectious disease transmission; Respiratory infections caused by bacteria and viruses, Tuberculosis; Sexually transmitted disease including AIDS, Disease transmitted by animals (rabies and plague) and insects and ticks (rickettsias and malaria); Food and waterborne diseases; pathogenic fungi, emerging and resurgent infectious diseases; Viruses, viroids, and prions; Microbial control of pathogenesis.	
Total		42

Books:-

S.No.	Name of Books/ Author/Publisher
1.	Microbiology by M.J. Pelczar, E.C.S. Chan and N.R. Kreig. Publisher: Tata McGraw Hill (2005)
2.	Microbiology by Bernard D. Davis, Renato Dulbecco, Herman N. Eisen and Harold S. Ginsberg. Publisher: Lippincott Williams & Wilkins (1990)
3.	Brock Biology of Microorganisms by M.T. Madigan, J.M. Martinko and J. Parker. Publisher: Prentice-Hall, Inc (1997)
4.	General microbiology by R.Y. Stanier, J.L. Ingraham, M.L. Wheelis and P.R. Painter. Publisher: Macmillan (1987)
5.	Microbiology by Prescott Harley and Klein. Publisher: Mc Graw Hill (2007)

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Advances in computational biology (BT 208)	3	0	2	

Course Objective: The course advances in computational biology integrates genetics and genetics with recent advancement in the field, including personalized medicine, soft computation in biological sciences. The course also integrates laboratory skills necessary for implementation of research ideas

Course Outcome (CO):

- 1 Integrate multi-domain knowledge of the basic concepts of biology, computer science and mathematics.
- 2 Analyze the biological data through relevant computer algorithms.
- 3 Assess and evaluate structure-function relationships of biomolecules in-silico.
- 4 Assign formulations to rapidly probe various aspects of bioinformatics.
- 5 Acquire insights about analyzing big datasets.
- 6 Interpret sequence analysis results.

S.No.	Content	Contact Hours
Unit 1	Human Genetic Variation: Databases and Concepts: Introduction, Forms and mechanisms of genetic variation, Databases of human genetic variation, SNP databases, Mutation databases, Genetic marker and microsatellite databases, Nonnuclear and somatic mutation databases, Tools for SNP and mutation visualization.	8
Unit 2	Structure Databases: PDB and MMDB, visualizing structural information	8
Unit 3	Pharmacogenomics and Personalized Medicine: Introduction, Historical Perspectives and Current Status, Management of Pharmacogenomic Information: PharmGKB, DrugBank.	8
Unit 4	Phylogenetic prediction: Types, Tree building methods and tree interpretation analysis	9
Unit 5	Soft Computation: Machine learning, support vector machines, Neural Networks, fuzzy logic, genetic algorithms - applications to bioinformatics.	9
Total		42

Books:-

S.No.	Name of Books/ Author/Publisher
1.	All About Bioinformatics: From Beginner to Expert- Yasha Hasija (2023)
2.	Hands on Data Science for Biologists Using Python- Yasha Hasija, Rajkumar Chakraborty (2021)
3.	Bioinformatics and Functional Genomics, 3rd Edition Jonathan Pevsner (Wiley-Blackwell; published in association with Oxford University Press) (2015)
4.	Translational Biotechnology:A Journey from Laboratory to Clinics. Editor- Yasha Hasija (2021)
5.	Introduction to Bioinformatics - Arthur M. Lesk Oxford University Press (2019)

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Biochemistry (210)	3	0	2	

Course Objective:

To impart basic knowledge of biochemistry and biochemical principles for cell metabolism and bioenergetics.

Course Outcome (CO):

- 1 Analyze the biogenic properties of water and interactions in biological systems
- 2 Compare different types of biomolecules
- 3 Analyze carbohydrate metabolism
- 4 Explain digestion, absorption and transport of lipid and cholesterol metabolism
- 5 Understand amino acid and nucleotide metabolism

S.No.	Content	Contact Hours
Unit 1	Chemical Foundations of Biology: Properties of water; Biogenic properties of water; Buffers; Covalent bonds, Non-covalent interactions in biological systems	7
Unit 2	Introduction to Biomolecules: Classification, structure and functions of Carbohydrates, Lipids, Proteins, Nucleic acids; Vitamins	8
Unit 3	Carbohydrate Metabolism: Glycolysis; Citric acid cycle; Gluconeogenesis, Pentose Phosphate Pathway, Electron transport chain; Oxidative phosphorylation; Regulation of carbohydrate metabolism	10
Unit 4	Lipid Metabolism: Lipid digestion, absorption and transport; Fatty acid oxidation; Ketone bodies; Fatty acid biosynthesis; Regulation of fatty acid metabolism; Cholesterol metabolism	9

Unit 5	Amino acid and Nucleotide Metabolism: Amino acid deamination; Urea cycle; Amino acid biosynthesis; Amino acids as biosynthetic precursors; Metabolism of purines and pyrimidines; Biosynthesis of nucleotide coenzymes	8
Total		42

Books:-

S.No.	Name of Books/ Author/Publisher
1.	Lehninger's Principle of Biochemistry by DL Nelson, MM Cox. Publisher: WH Freeman
2.	Biochemistry by D Voet, JG Voet. Publisher: Wiley
3.	Harper's Illustrated Biochemistry by VW Rodwell, D Bender, KM Botham, PJ Kennelly, PA Weil. Publisher: McGraw Hill
4.	Biochemistry by CK Mathews, KE Van Holde, KG Ahern. Publisher: Benjamin/Cummings
5	Biochemistry by L Stryer. Publisher: WH Freeman and Company

## Scheme and Syllabus (BTech 3<sup>rd</sup> year)

### Fifth semester

<u>S.No.</u>	Subject code	<u>Subject</u>	<u>Credits</u>	<u>Category</u>
1.	BT301	Immunology and Immunotechnology (Department core course-10)	4	DCC
2.	BT303	Genetic Engineering (Department core course-11)	4	DCC
3.	BT305	Environmental Biotechnology (Department core course-12)	4	DCC
4.	BT307	Engineering economics/ Fundamentals of Management	3	SEC
5.	BT3xx	Department Elective Course-1	4	DEC
6.	GEC-1	Generic Elective Course-1	4	GEC
		Total	23	

### Sixth semester

<u>S.No.</u>	Subject code	<u>Subject</u>	<u>Credits</u>	<u>Category</u>
1.	BT302	Plant Biotechnology (Department core course-13)	4	DCC
2.	BT304	Animal Biotechnology (Department core course-14)	4	DCC
3.	BT306	Engineering economics/ Fundamentals of Management	3	SEC
4.	BT3xx	Department Elective Course-2	4	DEC
5.	BT3xx	Department Elective Course-3	4	DEC
6.	GEC-2	Generic Elective Course-2	4	
		Total	23	

**Course: Immunology and Immunotechnology** (Department core course-10)

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Immunology and Immunotechnology (BT301)</b>	3	0	2	Nil

**Course Objective:** To give an overview of the basic concepts in immunology and the development of diagnostic and therapeutic techniques in immunotherapy for complex disorders and infectious diseases.

**Course Outcome (CO):**

1. Understanding innate and adaptive immunity and exploring their role in immune response to pathogens.
2. Detailed understanding of the role of innate immunity as the first line of defense
3. Analysing the role of the adaptive immune system in complex immune therapeutics.
4. Learning the principles of immune tolerance, identifying the causes and mechanisms of autoimmune disease and immunodeficiencies, hypersensitivity reactions and cancer biology
5. Equip students with the knowledge of immunology for application in developing techniques for diagnostics and therapeutics

S.No	Content	Contact Hours
<b>Unit 1</b>	<b>Introduction and overview of the Immune system</b> Introductory concepts in immunology; Active and passive immunity; principles of the innate and active immune system; cells and organs of the immune system; and Hematopoiesis.	<b>10</b>
<b>Unit 2</b>	<b>Innate immune system</b> Mechanisms of the innate immune response, neutrophils, NK cells, dendritic cells, macrophages, and cytokines, as well as their role in immune response, are components of the complement pathway.	<b>8</b>
<b>Unit 3</b>	<b>Adaptive immune system</b> Antigen presentation by MHC class I & class II; T cell response; regulation of cellular immune response; Antibody structure and types; Antibody gene rearrangement; Clonal selection; and B& T cell epitope analysis.	<b>8</b>
<b>Unit 4</b>	<b>Immunity and health care</b>	<b>10</b>

	Central and peripheral tolerance; Autoimmunity causes and treatment; systemic & local autoimmune disease; Hypersensitivity and its types; Cancer biology	
<b>Unit 5</b>	<b>Immunotechnology</b> Antibody Engineering Immune diagnostics; Immunological techniques: agglutination, precipitation, immunodiffusion, ELISA, ELISPOT, RIA, Immunoelectrophoresis, Flowcytometry	<b>9</b>
	<b>Total</b>	<b>45</b>

**Practical:**

Sno.	Aims
1	Identify primary and secondary lymphoid organs using permanent slides and understand their histological features and functions.
2	Study of Radial Immuno diffusion as a diagnostic tool.
3	Study of Double Immuno diffusion as diagnostic tool.
4	Blood smear identification of leucocytes by Giemsa stain
5	Elucidating Antibody titre by ELISA method.
6	Elucidation of advanced techniques of immune diagnostics like Immuno-electrophoresis
7	Blood smear identification of leucocytes by Giemsa stain
8	Separation of mononuclear cells by Ficoll-Hypaque
9	Study of Flowcytometry; identification of T cells and their subsets using Flowcytometry
10	Identification of blood groups using agglutination

**Reference Books/ links :**

S.No.	Name of Books/Authors/Publisher
1.	"Kuby Immunology" by Judy Owen; Jenni Punt; and Sharon Stranford (2018) Publisher: W.H. Freeman & Company
2.	"Janeway's Immunobiology" by Kenneth Murphy; Casey Weaver; and Allan Mowat (2016) Publisher: Garland Science
3.	Basic Immunology by A.K. Abbas and A.H. Lichtman. Third edition. Publisher: Saunders W.B. Company ;2010
4.	How the Immune System Works" by Lauren M. Sompayrac (2019) Publisher: Wiley-Blackwell
5.	"Cancer Immunotherapy"Immune Suppression and Tumor Growth 2nd Edition - June 4; 2013 Editors: George C. Prendergast; Elizabeth M. Jaffee Publisher: Academic Press
6.	Microbial Crosstalk with Immune System by Asmita Das (2022) Academic Press

**Details of course: - Genetic Engineering (Department core course-11)**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Genetic Engineering (BT 303)</b>	3	0	2	Nil

**Course Objective:** Basic understanding of genetic engineering tools, gene manipulation, gene delivery rDNA Technology, Library construction and industrial application of gene cloning.

Course Outcome:	
I.	Understanding of basic principle of gene cloning and vectors used for cloning in different type of cells.
II.	Knowledge of various tools and enzymes deployed for manipulation and modification of DNA.
III.	Comparison of various methods deployed for gene delivery in host and identifying recombinant cells.
IV.	Learning of skills for construction of DNA libraries and utilization of expression system.

V.	Appraisal of industrial applications of gene cloning and understanding of various challenges and ethical issues.
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S. No.	Content	Contact Hours
Unit 1	<b>Gene cloning vectors:</b> Isolation and purification of DNA, vectors for gene cloning: Plasmids, bacteriophages, cloning vectors for eukaryotes, cloning vectors for higher plants, cloning vectors for animals.	<b>8</b>
Unit 2	<b>DNA manipulation:</b> DNA manipulative and modifying Enzymes, mechanism of action, Restriction Endonucleases, restriction mapping and map construction, DNA methylase, Ligation.	<b>8</b>
Unit 3	<b>Gene Delivery and Identification of Recombinant Clones:</b> Methods for introduction of DNA into living cells: Transformation, Recombinants identification methods; An overview of PCR and variations; Selection & screening of recombinants clones and Reporter gene expression, RNA interference and site directed mutagenesis.	<b>9</b>
Unit 4	<b>Library Construction and Expression System:</b> Genomic and cDNA library construction; Studying gene expression, regulation and function; various expression system used in prokaryotes and eukaryotes; Methods for identification of translation product.	<b>9</b>
Unit 5	<b>Application of Gene cloning:</b> Production of recombinant proteins, Scale-up operations of recombinant cells, Pharming, Gene Therapy, Ethical issues and concerns.	<b>8</b>
	Total	42

### List of Experiments

S.NO.	TITLE
<b>Experiment 1</b>	To prepare LB media.
<b>Experiment 2</b>	Sterilization and pouring of LB media.
<b>Experiment 3</b>	To perform streaking of E. coli on LB media plates.

<b>Experiment 4</b>	To isolate plant genomic DNA by CTAB method
<b>Experiment 5</b>	Isolation of plasmid DNA from E. coli cells
<b>Experiment 6</b>	To check the presence of DNA by Agarose gel Electrophoresis
<b>Experiment 7</b>	To electro elute specific bands or regions of agarose gel separated DNA
<b>Experiment 8</b>	To prepare competent cells by calcium chloride method
<b>Experiment 9</b>	To perform PCR thermal cycler for DNA amplification
<b>Experiment 10</b>	To transform competent cells with pUC18- $\lambda$ DNA ligated product

Books:

S.No.	Name of Book/Author/Publisher
1.	Gene Cloning & DNA Analysis: An Introduction by T.A. Brown. Blackwell Publisher,
2.	Principles of Gene Manipulation & Genomics by Primrose & Twyman. Seventh edition
3.	Molecular Cloning: A Laboratory Manual (3 Volume Set) by J. Sambrook and David W. Russel. Third edition Publisher: Cold Spring Harbor Laboratory Press,
4.	Molecular Biotechnology: Principles and Applications of Recombinant DNA by B.R. Glick and J.J. Pasternak. Publisher: ASM Press
5.	Genetic Engineering by S. Rastogi and N. Pathak. Publisher: Oxford University Press
6.	Recombinant DNA by J.D. Watson et al. Publisher: W.H. Freeman and company

**Details of course: - Environmental Biotechnology (Department core course-12)**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Environmental Biotechnology (BT 305)	3	1	0	Nil

Course Objective:

To impart knowledge about the environment structure and its balance, Pollution and its measurement. The strategies to reduce the pollutant concentrations in the biosphere and strategies for sustainable ecosystem.

Course Outcome (CO):

- 1) To impart knowledge on different types of pollution in the environment
- 2) To understand sources, impacts and strategies for monitoring air, water and noise pollution
- 3) To study the solid waste management techniques and bioremediation
- 4) To understand greenhouse effect, acid rain and ozone depletion
- 5) To study the microbiology for degradation of pollutants

S.No.	Content	Contact Hours
1.	<b>Environmental Pollution:</b> Types of pollution, methods for the measurement of pollution; Methodology of environmental management the problem- solving approach, its limitations	06
2.	<b>Air Pollution and its Control through Biotechnology:</b> Active trace gases in air, reactive odd nitrogen, carbon, sulfur and Halogen compounds in air, aerosols in air, direct and indirect effect on radioactive forcing, Bio-filtration	08
3.	<b>Water Pollution and its Control:</b> Water resource management, waste water collection, Measurement of water pollution, sources of water pollution, waste water treatment - physical, chemical and biological treatment processes. Activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic processes of biological treatment- Anaerobic digestion, anaerobic filters. Upflow anaerobic sludge blanket reactors; Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries	08
4.	<b>Global Environmental Problems:</b> Ozone depletion, greenhouse effect and acid rain, their impact and biotechnological approaches for management	06
5.	<b>Solid Wastes:</b> Treatment and Management: Sources of solid waste and management (composting, Vermiculture and methane production) Bioremediation of contaminated soils and waste land, Biopesticides in integrated pest management.	08
Total		36

**Books:-**

S.No.	Name of Books/ Author/Publisher
6.	Comprehensive Biotechnology by M. Moo- Young. 4-volume set Publisher: Pergarmon Press
7.	Environmental Chemistry AK. De. Publisher: New Age Publications (Academic) India)
8.	Introduction to Biodeterioration by D. Allsopp and K.J. Seal. Publisher ELBS/Edward Arnold.
9.	Microbiology by Bernard D. Davis, Renato Dulbecco, Herman N. Eisen and Harold S. Ginsberg. Publisher:Lippincott Williams & Wilkins
10.	Waste Water Engineering - Treatment and Reuse by Metcalf, Eddy and G. Tchobanoglous. Publisher: Tata McGraw Hill

**Details of course:- Engineering economics (SEC)**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Engineering Economics (BT 307)	3	0	0	

**Course Objective:**

To enable the students to understand the economic theories which may be applied to maximize return and economic environment in which they have to operate.

**Course Outcome (CO):**

- I. Elucidate the Nature and significance of economics, Preparation of Cost Sheet Profit Maximisation- numerical problem.
- II. Demonstrate Money its evaluation and function in Bank, Commercial Bank and Central Bank and brief idea about function of banking system,
- III. Elucidate the Role of Science, Engineering and Technology in Economic Development.
- IV. Explain the Elementary Economic Analysis such as the Interest formulas and their applications.

S.No.	Content	Contact Hours
1	Introduction: Nature and significance of economics, Goods and Utility, Basic Concept of Demand and Supply, Elasticity of Demand Price elasticity of Demand, Cross elasticity of Demand, Production - Production Function, Production Process and Factors of Production, Market – Introduction to Monopoly, Perfect Competition, Oligopoly and Monopolistic Competition, Cost Concepts- Opportunity Cost, Total Cost, Average Cost; Marginal Cost; Life Cycle cost, Sunk Cost; Preparation of Cost Sheet Profit Maximisation- numerical problem.	10
2	Money- its evaluation and function, Bank- Commercial Bank and Central Bank and brief idea about function of banking system:. Tax and Subsidy, Type of Tax- Direct and Indirect, Monetary and fiscal policy, Inflation and Business cycle, International trade, terms of Trade, Gain from International Trade, Free Trade vs. Protection, Dumping, Balance of Payment.	10
3	Role of Science, Engineering and Technology in Economic Development: Seven salient Feature of the Indian Economy; Inclusive Growth; relevance for the Indian Economy; Globalisation & opening up of the Indian Economy; GDP- definition and Its measurement; How knowledge of engineering and technology may be used to improve life at slum; Green Revolution and White revolution. Reasons for their success and can we replicate them. Appropriate Technology & Sustainable Development. Entrepreneurship: Macro environment for promotion of entrepreneurship: How environment has changed after advent of IT and Globalisation.	12
4	Elementary Economic Analysis: Interest formulas and their Applications; Calculations of economic equivalence, Bases for Comparison of Alternatives: Present Worth Method, Future worth method, Annual equivalent, Internal Rate of Return; Business Risk; Factors which should be taken care while deciding price of the product in the market.	10
Total		42

Books:-

S.No.	Name of Books/ Author/Publisher
1.	G.J. Thuesen, & W.J. Fabrycky, Engineering Economy, Pearson Education, 2007, ISBN 013028128X
2.	William G. Sullivan, Elin M. Wicks, C. Patrick Koelling, Engineering Economy, Prentice Hall,( First Indian reprint). 2009, ISBN 0131486497
3.	Donald G. Newman, Jerome P. Lavelle & Ted G. Eschenbach, Engineering Economic Analysis, Oxford University Press, USA , 2004, ISBN 0195168070

4.	Seema Singh, Economics for Engineering Students, IK International Publishing House Pvt. Ltd, 2014, ISBN 8190777041
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## Sixth Semester

### Details of course: - Plant Biotechnology (Department core course-13)

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Plant Biotechnology (BT 302)</b>	3	0	2	Nil

#### Course Objective:

To provide students with expert information on current and potential future developments in the area of plant biotechnology and to provide information on national and international norms and regulations in biotechnology

#### Course Outcome:

I.	Understanding of the basic concepts used in plant biotechnology and tissue culturing	
II.	Knowledge of production means and mass cultivation using tissue culturing	
III.	Analysis of various techniques used in genetical modifications of plant	
IV.	Knowledge of applicability of transgenics in solving various issues faced by humanity	
V.	Learning of regulatory issues and ethical concerns involved in plant genetic engineering	
S. No.	Content	Contact Hours
Unit 1	<b>Introduction to plant biotechnology and culture techniques:</b> Historical perspectives, sterilization techniques, nutrient media, role of phytohormones; Callus, cell and protoplast cultures; Micropropagation; Organogenesis and somatic	8

	embryogenesis; Ovule culture; Anther culture; Production of haploids; Protoplast isolation and fusion; Selection systems for somatic hybrids / cybrids; Somaclonal variation; Preservation of germplasm.	
Unit 2	<b>Formation of Secondary Metabolites in Tissue Culture:</b> Production of pharmaceuticals by tissue culture; Biotransformation using plant cell cultures; Bioreactor system and models for mass cultivation of plant cells, hairy root culture	8
Unit 3	<b>Plant Genetic Engineering Techniques:</b> Gene transfer techniques (vector mediated and vector less gene transfer), transgenic plants, <i>trans</i> gene integration and expression, <i>trans</i> gene silencing, protein targeting, chloroplast transformation, targeted gene transfer.	9
Unit 4	<b>Applications of Transgenic Techniques:</b> Transgenic crops with new traits –herbicide tolerance, insect and disease resistance, pathogen free plants, nutrient quality, post harvest quality traits, fruit ripening, edible vaccines, Molecular farming for therapeutic protein	9
Unit 5	<b>Regulation of Plant Genetic Engineering:</b> National Regulatory Mechanism; Public Concerns Related to Plant Genetic Engineering	8
	Total	42

### List of Experiments

S.NO.	Experiments
1.	Establishment of standard plant tissue Culture laboratory
2.	Different techniques for the sterilization of culture vessels, media and maintenance of aseptic Condition
3.	To prepare different stock solutions of MS media for plant tissue culture
4.	To prepare 1L of MS media for tissue culturing

5.	To sterilize explants with different sterilizing agents
6.	Establishment of cultures from shoot tips of plant
7.	Clonal propagation of plant by induction of adventitious buds.
8.	To isolate and inoculate anthers for haploid production
9.	Demonstration of somatic embryogenesis in plant.
10.	To induce callus from an explant

Books:

S.No.	Name of Book/Author/Publisher
1.	Introduction to Plant Biotechnology by H. S. Chawla Publisher: Oxford and IBH Publishing
2.	An Introduction to Plant Tissue Culture by M.K. Razdan. Publisher: Oxford and IBH Publishing
3.	Gene Cloning and DNA Analysis by T A Brown. Blackwell Publishing

### **ANIMAL BIOTECHNOLOGY (Department core course-14)**

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Animal Biotechnology (BT 304)</b>	3	0	2	Nil

**Course Objective:** To impart the knowledge of the most recent techniques used in animal biotechnology and their application to animal husbandry and biomedical field

**Course Outcomes:**

1	Enlist basic principles of animal cell culture.
2	Define animal diseases and outline the therapy and variation of diseases.
3	Assess the intricacies of stem cells
4	Describe the basic principle behind transgenic, knock in and knock out animal.
5	Identify monoclonal antibodies.

S. No.	Content	Contact Hours

Unit 1	Animal cell culture, basic principles, serum free and serum based media, scaling-up, characterization and preservation of cell lines, cytotoxicity and viability assays	10
Unit 2	Animal diseases, diagnosis, therapy, variations of diseases, modes of transmission of diseases, control and management of disease spreading	8
Unit 3	Stem cells, micromanipulation of embryos, generation of modified stem cells.	7
Unit 4	Transgenic animals, retroviruses and DNA microinjection method, knock in and knock out animals.	10
Unit 5	Monoclonal antibody and hybridoma technology, application of mAb in diagnostics and therapeutics, vaccinology	10
	Total	45

**Practicals:**

1. Trypan blue dye exclusion assay for cell viability.
2. Different steps in the development of primary cell culture.
3. Animal cell culture techniques
4. Handling of differentiated and cancer cell lines.
5. Transfection of plasmid DNA to cell lines.
6. Cell proliferation assays.
7. Diagnostics of animal-based diseases

**Books:**

S.No	Name of Book/Author/Publisher
1.	Gene cloning & DNA Analysis: An introduction by T A Brown, Fourth edition
2.	<b>Animal Cell Biotechnology, Methods and Protocols</b> Publisher: Humana Press
3.	Pinkart, C.A., "Transgenic Animal Technology", Academic Press Inc.
4.	Sasidhara, R., "Animal Biotechnology", MJP Publishers

**Details of course: - Fundamentals of Management (SEC)**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Fundamentals of Management (BT 306)	3	0	0	

**Course Objective:**

The basic objective of this paper is to acquaint the students with the basic concepts of management necessary to deal with emerging business environment besides sensitizing them about societal challenges.

**Course Outcome (CO):**

- 1 Define management its importance, management principals, managerial roles, managerial ethos.
- 2 Explain the Concept of business environment, corporate social responsibility
- 3 Illustrate the Objectives and importance of financial management its basics of capital budgeting, and financial approaches.
- 4 Compare and Contrast marketing vs sales, new product development and some unethical issues in marketing.
- 5 Elucidate the knowledge of management such as knowledge of society, knowledge of economy, challenges in Indian context for example Digital India programme.

S.No.	Content	Contact Hours
1	Definition of management, importance of management, management principals, managerial roles, managerial ethos, management vs administration, managerial functions, task and responsibilities, organizational structure, motivation: meaning, theories and techniques	8
2	Concept of business environment, corporate social responsibility and corporate governance, managerial values and ethics	8
3	Objectives and importance of financial management, basics of capital budgeting, cost of capital, emerging sources of funds for new projects, introduction to stock market	9
4	Functions of marketing, marketing vs sales, interface of marketing with other departments, customer life time value, new product development, unethical issues in marketing	8

5	Introduction to knowledge management, knowledge society, knowledge economy, building knowledge assets, sources of knowledge, technology innovation process, E-governance: definition, objectives and significance; challenges in Indian context, Digital India programme	9
Total		42

Books:-

S.No.	Name of Books/ Author/Publisher
1.	Fundamental of Management, Stephen P. Robbins, David A. De Cenzo and Mary Coulter, Pearson Education, ISBN- 978-0273755869, 2011
2.	Financial Accounting, 4 ed, S.N. Maheshwari and S.K. Maheshwari, Vikas Pulication, ISBN- 8125918523, 2005
3.	Management, James A F Stonner, Pearson Education, ISBN - 9788131707043 , 2010
4.	Marketing Management, 14th ed., Philip Kotler , Kevin Lane Keller, Abraham Koshy and Mithileswar Jha, Pearson Education, New Delhi, (ISBN-10: 9788131767160), 2013
5.	Knowledge Management in Organizations: A Critical Introduction, Donald Hislop, Oxford University Press, ISBN: 9780199691937,2013

## Scheme and Syllabus (BTech 4<sup>th</sup> year)

### Seventh semester

<u>S.No.</u>	<u>Course code</u>	<u>Subject</u>	<u>Credits</u>	<u>Category</u>
1.	BT401	B.Tech Project -I	4	DCC
2.	BT403	Internship	2	DCC
3.	BT4xx	Department Elective Course-4	4	DEC
4.	BT4xx	Department Elective Course-5	4	GEC
5.	GEC-3	Generic Elective Course-3	4	GEC
6.	VAC	Indian knowledge system	Non Credit	VAC
		Total	18	

### Eight semester

<u>S.No.</u>	<u>Course code</u>	<u>Subject</u>	<u>Credits</u>	<u>Category</u>
1.	BT402	B.Tech Project -II	8	DCC
3.	BT4xx	Department Elective Course-6	4	DEC
4.	GEC-4	Generic Elective course-4	4	GEC
		Total	16	
		<b>Cumulative credits</b>	<b>164*</b>	

### List of Departmental Elective Courses

<b>S. No.</b>	<b>Elective Code</b>	<b>Title of Elective</b>	<b>Elective no.</b>
1.	BT-309	Instrumentation in Biotechnology	
2.	BT-311	Food Biotechnology	
3.	BT-313	Object oriented Programming	
4.	BT-315	Introduction to Biomedical Engineering	
5.	BT-317	Thermodynamics of Biological System	
6.	BT-319	Current topics in Biotechnology	
7.	BT-321	Cancer Biology	

8.	BT-323	Pharmacogenomics and Personalized Medicine	DEC 1
9.	BT-325	Drug Design and Delivery	
10.	BT-327	Minor Project (Only for students who opt for Minor)	
11.	BT-308	Stem Cells and Regenerative Medicine	DEC 2
12.	BT-310	Metabolic Engineering	
13.	BT-312	Ecology and Evolution	
14.	BT-314	Transgenic Technology	
15.	BT-316	Bioenergy and Biofuels	
16.	BT-318	Enzymology and Enzyme Technology	
17.	BT-320	Protein Engineering	
18.	BT-322	Technological Application in Food Technology	
19.	BT-324	Medical Microbiology	
20.	BT-326	Industrial Biotechnology	
21.	BT-328	Concepts in Neurobiology	DEC3
22.	BT-330	Bioinformatics approaches in Complex disorders	
23.	BT-332	Plant Bioinformatics	
24.	BT-334	Biomaterials	
25.	BT-336	Nano-Biotechnology and Nanomedicine	
26.	BT-338	Biomaterials and clinical devices	
27.	BT-340	Basic Epidemiology	
28.	BT-342	Biodiversity and Bioresource planning	
29.	BT-344	Principle of imaging processing in medicine	
30.	BT-346	Genomics and Proteomics	
31.	BT-405	Structural Biology	DEC-4
32.	BT-407	Principles and practice in Public Health	
33.	BT-409	Rehabilitation Engineering	
34.	BT-411	System Biology	
35.	BT-413	Advanced Bioanalytical Techniques	
36.	BT-415	Clinical Biotechnology	
37.	BT-417	Plant Metabolic Engineering	
38.	BT-419	Crop protection and Pest management	
39.	BT-421	Biosensor	

40.	BT-423	Green Energy Technology	DEC-5
41.	BT-425	Food Engineering & Biotechnology	
42.	BT-427	Waste water treatment	
43.	BT-429	Bioprocess Plant Designing	
44.	BT-431	Bioethics and Intellectual Property Rights	
45.	BT-433	Biomedical Instrumentation, biosensor and transducer	
46.	BT-435	Biostatistics	
47.	BT-404	Bioprocess Plant Design	DEC-6
48.	BT-406	Population Genetics	
49.	BT-408	Biopolymers	
50.	BT-410	Genomics in Medicine	
51.	BT-412	Nanobiotechnology	
52.	BT-414	Medical Physics	
53.	BT-416	Pharmaceutical Sciences	
54.	BT-418	Agriculture Microbiology	
55.	BT-420	Nutraceuticals	
56.	BT422	Tissue Engineering and Artificial Organs	

## Instrumentation in Biotechnology

### Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Instrumentation in Biotechnology (BT309)</b>	3	1	0	NIL

### Course Objective:

To impart broad knowledge of commonly used instruments and their working principles

### Course Outcomes:

1. To define the global significance of biotechnology and examine the potential applications of Biotechnology in all sectors of life.
2. To compare prokaryotic and eukaryotic cellular architecture.
3. To comprehend the functioning of various biomolecules and enzymes and to compare various microorganisms.
4. To explain the underlying mechanism of gene expression, explain and appraise the genetic engineering of organisms for human welfare, and formulate new ideas.
5. To explain and translate separation, purification and identification techniques for biomolecules in research.

S. No.	Contents	Contact Hours
1.	<b>Hydrodynamic Techniques: Centrifugation:</b> Viscosity and diffusion, sedimentation equilibrium and sedimentation velocity methods, analytical and Preliminary centrifuges, application of density gradient and differential centrifugation; cell disruption techniques.	<b>8</b>
2.	<b>Electrophoretic Techniques:</b> Paper and gel electrophoresis, Immunoelectrophoresis, isoelectric focusing, two - dimensional electrophoresis, capillary electrophoresis.	<b>7</b>
3.	<b>Chromatographic Methods, Chemo Sensors and Biosensors:</b> Paper, TLC gas chromatography, gel filtration, ion-exchange chromatography, affinity chromatography and HPLC, FPLC, adsorption and desorption.	<b>9</b>

	Sensors and transducers; Electrochemical sensors; Semiconductor devices as chemical sensors; Optical chemical sensors; Piezoelectric sensors; Sensor signal processing; Chemistry of biomolecules and their immobilization for biosensors; Types of biosensors and their application -Environmental monitoring, process control, and clinical/biochemical analysis; Amperometric biosensors; Immunosensors.	
4.	<b>Spectroscopic and Diffraction Techniques:</b> UV and visible, Spectro fluorimetry, atomic absorption spectrophotometry, Mass Spectrometry, Infrared and Raman Spectroscopy, Mossbauer, MALDITOF, ORD and Circular Dichroism, Nuclear Magnetic Resonance and Electron Spin Resonance spectroscopy, X-Ray diffraction, Electron diffraction, Neutron Diffraction	<b>9</b>
5.	<b>Optical Techniques, Radioisotope Techniques, Microscopy:</b> Optical and Electron Microscopy, Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Polarization and Fluorescence microscopy. Radio tracers, GM Counter, Proportional and Scintillation Counters, autoradiography, radioimmunoassay (RIA).	<b>9</b>
	<b>Total</b>	<b>42</b>

**Books: -**

S. No.	Name of Authors /Books / Publishers
1.	Principles and Techniques of Practical Biochemistry by Keith Wilson and John Walker, Fifth edition, Cambridge University Press
2.	Biophysical Chemistry: The conformation of Biological Macromolecules by C.R.Cantor and P.R. Schimmel. Publisher: W.H. Freeman
3.	Essentials of Biophysics by P. Narayanan. Publishers: New Age International Publishers
4.	Introduction to Spectroscopy by D.L. Pavia, G.M. Lampman and G. S. Kriz.and Vyvyan Publisher: Brooks Cole
5.	Principles of Physical Biochemistry by Kensal E. Van Holde, Curtis Johnson, K.E. Van Holde., W.Curtis Johnson and Pui Shing Ho. Publisher: Prentice Hall.
6.	Process Biotechnology Fundamentals by S N Mukhopadhyay. Publisher: Viva Books Pvt. Ltd., New Delhi.
7.	Microbiology by Bernard D. Davis, Renato Dulbecco, Herman N.Eisen and Harold S. Ginsberg. Publisher: Lippincott Williams & Wilkins

**Biotechnology**

**Details of course:-**

Course Title	Course Structure	Pre-Requisite
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	<b>L</b>	<b>T</b>	<b>P</b>	
<b>Food Biotechnology (BT311)</b>	3	1	0	NIL

**Course Objectives:**

To impart a broad understanding of food technology, industrial food production and product regulations.

**Course Outcomes:**

1.	To understand food biotechnology, the scope of food biotechnology and its tools for trade.
2.	To master recombinant proteins and their biological roles.
3.	To elucidate the application of plant biotechnology in food.
4.	To understand cell culture and Food (Brewing, dairy biotechnology, food additives) in Diagnostic Systems.
5.	To apprehend a biotechnological approach for exploiting food and industrially important microorganisms, Bio Gas Plant.

<b>S. No.</b>	<b>Contents</b>	<b>Contact Hours</b>
1	Scope of Food Biotechnology (What is the difference between food technology and food biotechnology?) Tools of the Trade (How biotechnology techniques relate to food?)	<b>8</b>
2	Recombinant Proteins (Production and applications in food), Biological Role of DNA in cell metabolism, Cell and tissue culture, Secondary metabolites synthesis .	<b>7</b>
3	Plant biotechnology in foods (Application to food production, food industries, pharmaceuticals, and agriculture)	<b>9</b>
4	Cell Culture and Food (Brewing, dairy biotechnology, food additives), Diagnostic Systems (How and Why and application in food) Industrial Cell culture (Downstream processing Ethics and safety of food biotechnology products Regulations of food biotechnology	<b>9</b>
5	Biotechnological Approach for the exploitation of food and industrially important microorganism, Bio Gas Plant	<b>9</b>
	<b>Total</b>	<b>42</b>

Books: -

<b>S. No.</b>	<b>Name of Authors /Books / Publishers</b>
1.	Advances in Biotechnology Vol.1, (Scientific and Engineering principles). Murray Moo-Young, C.W. gambell and C.Vezina

2.	Advances in biotechnology Vol-II, (Fuels, chemical. food and waste treatment) Murray Moo-Young, C.W. gambell and C.Vezina.
3.	Introduction to Plant Biotechnology, H. S. Chawla
4.	Fundamentals of Food Biotechnology By Byong H. Lee, wiley publications
5.	Food Biotechnology in Ethical Perspective edited by Julie Eckinger, second edition by Paul P Thompson.

### Object-oriented Programming

#### Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Object-oriented Programming (BT313)</b>	3	1	0	NIL

**Course Objective:** Basics of programming language and application

#### Course Outcomes:

1. Discuss the fundamentals of object-oriented paradigm and C++.
2. Outline classes and objects, objectives of C++ and characteristics.
3. Introduce dynamic objects, pointers to objects, array of objects, pointers to object members, this pointer, self-referential classes.
4. Understanding of Operator overloading and Inheritance.
5. Evaluate the generic programming with templates their functions and different types. Analyse data types, byte code and the basics of programming language.

S. No.	Contents	Contact Hours
1	<b>Object oriented paradigm &amp; C++ at a glance:</b> Evolution of programming paradigm, structured versus object-oriented development, elements of object-	<b>8</b>

	oriented programming, Objects, classes, methods, popular OOP languages, software reuse.	
2	<b>Classes and objects:</b> Introduction, Class revisited, constant objects and constructor, static data members with constructors and destructors, constructor overloading, nested classes, objects as arguments, returning objects, friend functions and friend classes, constant parameters and member functions, static data and member functions.	<b>7</b>
3	<b>Dynamic objects:</b> Introduction, pointers to objects, array of objects, pointers to object members, this pointer, self-referential classes	<b>9</b>
4	<b>Operator overloading and Inheritance:</b> Overloading of new and delete operators, conversion between objects and basic types, conversion between objects of different classes, overloading with friend functions, abstract classes, inheritance types , virtual base classes, virtual functions, pointer to derived class objects, and base class objects, pure virtual functions, virtual destructors.	<b>9</b>
5	Generic programming with templates: Introduction, function templates, overloaded function templates, class templates, inheritance of class template, class template containership, class template with overloaded operators. Introduction to byte code, security and portability, Data Types, variables, operators, arrays, type conversion and casting, type promotion, Control statements, standard input-output, Designing Classes, constructors, methods, access specifies : public, private, protected, inheritance, packages and interfaces, Math, String, Vectors, and Array List classes, polymorphism: function and operator overloading, function overriding, abstract classes	<b>9</b>
	<b>Total</b>	<b>42</b>

Books: -

S. No.	Name of Authors /Books / Publishers
1.	E Balaguruswamy, "Object Oriented Programming with C++", The McGraw Hill Companies
3.	Patrick Naughton, S. Herbert, "C++: The Complete Reference", Wiley Dream Tech
4.	Jeri R.Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", Pearson Addison-Wesley
5.	Behrouz A. Forouzan, Richrad F. Gilberg "A structured Programming Approach Using C", Thomson Computer Science-3rd edition [India edition] (2007)
6.	Budd, "An Introduction to Object Oriented Programming", Addison Wesley
	K.R.Venugopal, Rajkumar Buyya, T.Ravishankar, "Mastering C++", TMH
7	Lippman and Lajoie, "C++ Primer ", Addison Wesley

### Introduction to Biomedical Engineering

Details of course:-

Course Title	Course Structure	Pre-Requisite
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	<b>L</b>	<b>T</b>	<b>P</b>	
<b>Introduction to Biomedical Engineering (BT315)</b>	3	1	0	NIL

**Course Objectives:** The main goal of subject is to introduce students to the application of engineering science to biomedical problems and to apply basic principles of science and engineering to study living functions and to understand the operation of biomedical instruments.

**Course Outcomes:**

1. Distinguish between different types of roles of biomedical engineering and intro to anatomy and physiology of the human body.
2. Outline basics and principles of rehabilitation engineering.
3. Identify the basic bioinstrumentation system, design, and biomedical sensors.
4. Critically analyse different instrumentations and imaging devices like MRI, biomedical optical imaging.
5. Evaluate the molarity and ethics of biomedical engineering in FDA process.

<b>S. No.</b>	<b>Contents</b>	<b>Contact Hours</b>
1	Introduction to Biomedical Engineering, Roles Played by Biomedical Engineers, Professional Status of Biomedical Engineering. Introduction: Anatomy and Physiology, Cellular Organization, Tissues, Major Organ Systems and Homeostasis	<b>8</b>
2	Introduction: Rehabilitation Engineering and Assistive Technology, Principles of Rehabilitation Engineering, Introduction of Biomaterials in Medicine: From Prosthetics to Regeneration, Tissue-Biomaterial Interactions, Tissue Engineering	<b>8</b>
3	Introduction to basic Bioinstrumentation System, Bioinstrumentation Design, Introduction to Biomedical Sensors, Basic Biophysics, Equivalent Circuit Model for the Cell Membrane Hodgkin–Huxley Model of the Action Potential. Introduction to Origin, Characteristics and Acquisition of Biosignals	<b>9</b>
4	Instrumentation and Imaging Devices, Radiographic Imaging Systems, Introduction of Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging (MRI), Biomedical Optical Imaging, Fundamentals of Light Propagation in Biological Tissue, Physical Interaction of Light and Physical Sensing, Biochemical Measurement Techniques Using Light, Fundamentals of Therapeutic Effects of Lasers	<b>9</b>

5	Biomedical Morality and Ethics: A Definition of Terms, Regulation of Medical Device Innovation Marketing Medical Devices, The Role of the Biomedical Engineer in the FDA Process.	8
	<b>Total</b>	<b>42</b>

Books: -

S. No.	Name of Authors /Books / Publishers
1.	R. S. Khandpur, Handbook of Bio-Medical Instrumentation, Tata McGraw Hill, India, 2005
2.	L.a. Geddes, L.e. Baker, Principles of Applied Biomedical Instrumentation, 3rd edn., Wiley India Pvt. Ltd, New Delhi,
3.	J. D. Bronzino, Biomedical Engineering & Instrumentation, CRC Publication, Boca Raton, FL
4.	A. C. Guyton and E. Hall, Textbook of Medical Physiology, 11th edn., Elsevier

### Thermodynamics of Biological System

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Thermodynamics of Biological System (BT317)	3	1	0	NIL

**Course Objectives:** To gain insight into the concepts of nonbiological and biological thermodynamic systems, how are membrane transport and various metabolic processes facilitated

**Course Outcomes:**

1. Compare nonbiological and biological thermodynamics systems.
2. The course familiarizes the students with the laws of thermodynamics.
3. Fabricate the chemical potential of the laws in biological state.
4. Explain non-equilibrium thermodynamics using Fick's law.
5. Evaluate thermodynamics in biological systems

S. No.	Contents	Contact
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		<b>Hours</b>
1	<b>Introduction to Thermodynamic Systems:</b> Energetic process in the biosphere: The Ecosystem; Equilibrium, activity coefficients and phase equilibrium functions of state, cyclic processes, work, energy and metabolic heat; Mechanical equivalent of heat, energy as a function of state. Carnot cycle; Reverse Carnot cycle; use of heat transfer in biological processes	<b>9</b>
2	<b>The Laws of Thermodynamics:</b> Free energy; Entropy: Ideality and Molecular Cohesion, Probabilistic nature of Entropy, Order and Disorder	<b>8</b>
3	<b>Chemical Potential:</b> Visualization of the potential; Steady velocity and steady flow; Fick's law and diffusion; Local Equilibria and Steady State: Energy vs. Power; Transducers in biological states; Prigogine's principle; Spontaneous coupling and entropy production	<b>9</b>
4	<b>Non-equilibrium Thermodynamics:</b> Reversible work; Exact differentials and function of state; First and second law; The electrochemical potential; External forces and steady state; Fick's Law; Chemical reactions in the steady state; internal entropy production; Cells as non-equilibrium stationary states; Diffusion and membrane transport	<b>8</b>
5	<b>Thermodynamics of Biological Systems:</b> Biological Systems as open, non-equilibrium systems; Thermodynamic analysis of oxidative photophosphorylation; Stability of non-equilibrium stationary states; Ordering in time and space far from equilibrium; Glycolytic oscillations; Biological clocks	<b>8</b>
	<b>Total</b>	<b>42</b>

Books: -

<b>S. No.</b>	<b>Name of Authors /Books / Publishers</b>
1.	Bioenergetics by A.L. Lehninger. W.A. Benjamin Inc.
2.	Biological Thermodynamics by D.T. Haynie. Cambridge University Press
3.	Biophysical Chemistry by CR. Cantor and P.R. Schimmel. W.H. Freeman
4.	Thermodynamics and Kinetics for the Biological Sciences by G.G. Hammes. John Wiley and Sons Inc.
5.	Bioenergetics by Alexander Lowen. Penguin Books
6.	Bioenergetics by David G. Nicholls and Stuart Ferguson. Elsevier Ltd.
7.	<b>Principles of Bioenergetics by V. Skulachev, A.V. Bogachev, F.O. Kasparinsky. Springer-Verlag Berlin Heidelberg</b>
8.	<b>Thermal Biophysics of Membranes by T. Heimburg. Wiley-VCH</b>

**Current topics in Biotechnology**

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Current topics in Biotechnology (BT319)</b>	3	0/1	0	NIL

**Course Objectives:** To make the students aware of the thrust research areas in Biotechnology

**Course Outcomes:**

1. Classify stem cell research based on its characteristics, types and application.
2. Explain the different types of nuclear and molecular medicines.
3. Outline emerging field of nanotechnology and its applications.
4. Identify the type of GMO's their production and their current status.
5. Apprehend the applicability of biotechnology in Pharmacogenetics and translational research

S. No.	Contents	Contact Hours
1	<b>Stem cell research:</b> Stem cell: characteristics, types, preparation, applications, ethical concerns; Therapeutic and reproductive cloning; Regenerative medicine; Functional tissue engineering	<b>8</b>
2	<b>Molecular and Nuclear medicine:</b> Gene mutations; SNPs; Allele specific oligonucleotides; ARMS-PCR; Disease diagnostics using genetic markers; Molecular targeting of cancer cells; Radiotracers; PET/CT; MRI	<b>8</b>
3	<b>Nanobiotechnology:</b> Concepts; Applications; Molecular machines for biotechnology and medicine	<b>9</b>
4	<b>Transgenic technology:</b> Genetically modified organisms (GMOs); Legal requirements in the production of GMOs; Case study: Bt cotton; Current trends and consumer acceptance	<b>9</b>
5	<b>Pharmacogenetics and translational research:</b> Drug responses; Adverse drug reactions; Role in drug discovery and drug development; Conventional medicine versus personalized medicine; Clinical trial formulations; Advances in translational research	<b>8</b>
	<b>Total</b>	<b>42</b>

**Books: -**

S. No.	Name of Authors / Books / Publishers
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**Cancer  
Biology**  
**Details of  
course: -**

1.	Essentials of Stem Cell Biology by R. Lanza et al. 2 <sup>nd</sup> ed. Elsevier Academic Press
2.	Textbook of Molecular Medicine by J.L. Jameson. Blackwell Science Inc.
3.	Molecular Medicine: Genomics to Personalized Healthcare by R.J. Trent. Academic Press
4.	Molecular Medicine: An Introductory Text by R.J. Trent. Academic Press
5.	Nuclear Medicine and PET/CT: Technology and Techniques by P.E. Christian and K.M. Waterstram-Rich. 7 <sup>th</sup> ed. Mosby
6.	Essentials of Nuclear Medicine Imaging by F.A. Mettler Jr. and M.J. Guiberteau. 6 <sup>th</sup> ed. Saunders

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Cancer Biology(BT321)</b>	3	1	0	NIL

**Course Objectives:**

To give an understanding of the principles of cancer biology by studying the molecular and cellular basis of cancer

**Course Outcomes:**

1. To compare and contrast prokaryotic and eukaryotic cellular architecture and understand the mechanisms behind cell motility, shape, and strength.
2. To explain the underlying mechanism of cell cycle, cell division and programmed cell death.
3. To comprehend cell communication mechanisms.
4. To understand the process of protein targeting to various organelles.
5. To get insight into the causes of cancer and to devise strategies for specifically targeting cancer cells.

S.No	Content	Contact hours
1	<b>Introduction to cancer:</b> Nature of Cancer, Tumor Viruses, Discovery of oncogenes, Mutagens, Carcinogens, and Mutations.	<b>8</b>
2	<b>Avoiding Genomic Instability: DNA Replication, the Cell Cycle, and Cancer</b> The process of DNA replication, Mechanisms of oncogene activation, Role of growth factors and receptors in carcinogenesis	<b>8</b>
3	<b>p53 &amp; Apoptosis: Master Guardian and Executioner</b> Cell cycle control and the pRb tumor suppressor, Apoptosis and the p53 tumor suppressor	<b>8</b>
4	<b>Cell Immortalization, Tumorigenesis, &amp; Cancer Development</b> Cellular senescence, Telomeres, cellular immortalization, and tumorigenesis, Tumor-promoting stimuli, Cancer stem cells, DNA repair defects and their	<b>9</b>

	relationship to cancer.	
5	<b>Treatments for cancer</b> Traditional chemotherapies, Immunotherapy -targeted therapy, New genomic and proteomic technologies, Applications of new technologies in prevention, assessing risk, diagnostics, and treatment.	<b>9</b>
	Total	<b>42</b>

**Books: -**

S. No.	Name of Authors /Books / Publishers
1	The Biology of Cancer, Volume 1 Robert A. Weinberg Garland Science
2.	Dunmock N.J And Primrose S.B., “Introduction to Modern Virology”, Blackwell Scientific Publications, Oxford,
3.	“An Introduction Top Cellular And Molecular Biology of Cancer”, j Oxford Medical Publications,

**Pharmacogenomics and Personalized Medicine**

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Pharmacogenomics and Personalized Medicine(BT323)	3	1	0	NIL

**Course Objectives:**

The course incorporates the basics of Pharmacogenomics and its applications in personalized medicine

**Course Outcomes:**

1. Introduction to the roots of pharmacogenomics, learning its historical perspectives and status.
2. Understanding computational genome analysis of human genome.
3. Analysing of aspects influencing the method of selection and differentiating SNP and TaqMan Genotyping.
4. Analysing of aspects influencing the method of selection and differentiating SNP and TaqMan Genotyping.
5. Practical knowledge from different case studies

S. No.	Contents	Contact Hours
1.	Introduction to Pharmacogenomics: <b>The roots of pharmacogenomics, Historical Perspectives and Current Status</b>	<b>8</b>
2.	<b>The Human genome:</b> Computational genome analysis	<b>8</b>
3.	<b>Functional Analysis of Gene Variation &amp; Genotyping Techniques:</b> Aspects influencing method of selection, SNP Genotyping, TaqMan Genotyping	<b>8</b>
4.	<b>Pharmacogenomics in drug discovery:</b> The need of protein structure information, protein structure and variation in drug targets-the scale of problem, Mutation of drug targets leading to change in the ligand binding pocket.	<b>9</b>
5.	<b>Case Studies</b>	<b>9</b>
	<b>Total</b>	<b>42</b>

**Books: -**

S. No.	Name of Authors /Books / Publishers
1.	Pharmacogenomics: The Search for the Individualized Therapies”, Licinio, julio and Ma-Li Wong, Wiley-VCH,
2.	Pharmacogenomics: An Approach to New Drugs Development, Chakrabarthy, Chiranjib and Bhattacharyya, Atane,
3.	Pharmacogenomics: Social, Ethical and Clinical Dimensions, Rothstein, Mark, A.Wiley-Liss,

**Drug Design and Delivery**

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Drug Design and Delivery (BT325)</b>	3	1	0	NIL

**Course Objectives:**

To familiarize B.Tech students with concepts in Drug Design and Development with emphasis on the role of Bioinformatics in lead identification and lead optimization. Students are also being given in depth knowledge of the regulations involved in translation of ‘bench to bedside’ of a new drug and its IPR regulations.

**Course Outcomes:**

1. Illustrate the process of drug discovery and discussing the diverse sources of drugs.
2. Examine the traditional vs new age drug design and development.
3. Elucidate the receptor theory and role of enzyme kinetics in drug design and development.
4. Outline the role of clinical trials in drug development system.
5. Demonstrate the various drug delivery mechanisms for effective active drug concentration.

S. No.	Contents	Contact
		Hours
1.	Drug Discovery and development overview, Source of drugs, molecular screening strategies, traditional drug development	9
2.	'Bench to Bedside' translation of drugs, Preclinical drug development, Phases of Clinical Trials	8
3.	IPR regulations in drug development, Biosafety regulations	9
4.	Enzyme kinetics, Enzyme inhibition, Allosteric modulators, Enzymes as drug targets, Receptor Theory, Agonist and antagonist, Peptidomimetics	8
5.	Epitope mapping, synthetic vaccine design, concept of lead identification, Lead optimization, Rational drug design . Computational drug design, Docking, QSAR, Pharmacophore modeling, Recent advances in drug development.	8
	<b>Total</b>	<b>42</b>

**Books: -**

S. No.	Name of Authors /Books / Publishers
1.	Comprehensive Medicinal Chemistry ,C.Hansh 9Ed.);(vol I-VI)
2.	Design of Enzyme Inhibitors as Drugs,M.Sandler and H.J.Smith,Oxford University
3.	Drug Discovery and Design:Medical Aspects,J.Matsoukas and T.Mavromoustakos,IOS Press
4.	Drug Design Cutting Edge Approaches,Darren R Flower ,The royal society of Chemistry,Cambridge
5.	Protein folding and Drug Design ,R.A Broglia and L.Serrano,IOS Press

**Stem Cells and Regenerative Medicines****Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Stem Cells and Regenerative Medicines (BT308)</b>	3	1	0	NIL

**Course Objective:**

Introduction to stem cell technology and application

**Course Outcome (CO):**

1. Gain comprehensive knowledge of various stem cell types and their roles in development and repair.
2. Explain the use of stem cells in tissue engineering, organ transplantation, and disease treatment.
3. Develop hands-on skills in stem cell culture, differentiation, and genetic manipulation techniques.
4. Understand the ethical, legal, and social implications and regulations of stem cell research and therapy.
5. Analyze current research literature and propose new directions in stem cell and regenerative medicine research.

S. No.	Content	Contact Hours
1.	<b>Basic elements of stem cells and tissue engineering</b> Definition of stem cells, historical perspectives and various types of stem cells in use. Stem Cells – Basics, Properties and Classification, Stem Cells in Gastrointestinal, Liver, Pancreas, Kidney, Heart, Spinal Cord and Lung Regeneration Stem Cells in Eye Diseases and Disorders	8
2.	<b>Regenerative Medicine: from Bench to Bedside</b> The repair and regeneration of tissues for therapeutic purposes, such as replacing bone marrow in leukemia, cartilage in osteoarthritis or cells of the heart after a heart attack.	8
3.	<b>Molecularly Targeted Therapies in Blood Disorders and Malignancy</b> The discoveries of several novel regenerative treatments; Gene therapy, the potential of drugs based on RNA interference and the reprogramming of somatic cells into stem cells for regenerative medicine.	8

4.	<b>Developmental and molecular biology of regeneration</b> , pluripotent stem cells and genome engineering for modeling human diseases	9
5.	<b>Stem Cells: A Cure or Disease?</b> Recent developments in stem cell science, underlying biology behind the idea of using stem cells to treat disease, specifically analyzing the mechanisms that enable a single genome to encode multiple cell states ranging from neurons to fibroblasts to T cells.	9
TOTAL		42

**Books: -**

S. No.	Name of Books/ Author/Publisher
11.	Stem Cells and Regenerative Medicine, Walter C Low, Catherine M Verfaillie ISBN: 978-981-4, 2008
12.	Stem Cell Repair and Regeneration; Nagy Habib, Nataša Y Levičar, Myrtle Gordon, Long Jiao, Nicholas Fisk Volume 2,2008
13.	Developmental Biology, 6th Edition, Scott F. Gilbert, 2000
14.	Hematology, William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman, 2007
15.	Stem Cell Biology by Marshak, Cold Spring Harbar Symposium Publication, 2001

**Metabolic Engineering**

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Metabolic Engineering (BT310)</b>	3	1	0	NIL

**Course Objective:**

To impart basic knowledge of metabolic engineering, metabolic flux and applications of metabolic engineering

**Course Outcome (CO):**

1. Gain a comprehensive understanding of the fundamental principles of metabolic pathways and their regulation in various organisms.
2. Develop the ability to analyze and map metabolic pathways, including the identification of key enzymes and metabolites.
3. Learn techniques for genetic manipulation and enzyme engineering to alter metabolic pathways for desired outcomes.
4. Acquire proficiency in using computational tools and models to simulate and optimize metabolic networks for biotechnological applications.
5. Gain hands-on experience in laboratory techniques used in metabolic engineering, including cloning, gene editing, and metabolic flux analysis.

S. No.	Content	Contact Hours
1.	<b>Basic concepts of metabolic engineering:</b> Overview of cellular metabolism	8
2.	<b>Synthesis of primary and secondary metabolites</b>	8
3.	<b>Bioconversions:</b> Factors affecting bioconversions and Application	8
4.	<b>Metabolic Flux:</b> Integration of anabolism and catabolism, Regulation of Enzyme production	9
5.	<b>Metabolic engineering and Bioinformatics</b>	9
TOTAL		42

**Books: -**

S.No.	Name of Books/ Author/Publisher
1	Wang,D.I.C Cooney C.L., Demain A.L., Dunnill.P. Humphrey A.E. Lilly M.D., Fermentation and Enzyme Technology, John Wiley and sons
2	Stanbury P.F., and Whitaker A., Principles of Fermentation Technology,Pergamon Press
3	Metabolic Engineering: Principles and Methodologies <u>Gregory N. Stephanopoulos, Aristos A. Aristidou , Jens C. O. Nielsen</u>
4	Metabolic Engineering Sang Yup Lee, E. Terry Papoutsakis

**Ecology and Evolution**

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Ecology and Evolution(BT312)	3	1	0	NIL

**Course Objective:**

Ecology develops an understanding of the differences in structure and function of different types of ecosystems and familiarize with the variety of ways that organisms interact with both the physical and the biological environment while Evolutionary explanations pervade all fields in biology and bring them together under one theoretical umbrella. It increases understanding of the causes, processes and consequences of evolution.

**Course Outcome:**

1. Appraise the relevance of studying ecology and its history.
2. List abiotic factors, laws of limiting factors and other laws.
3. Define ecosystem, community, sustainable development trophic levels and nutrient cycles.
4. Discuss basics of evolution like Lamarckism, Darwinism, Neo-Darwinism
5. Impart knowledge of Population Genetics and evolutionary changes.

S.No.	Content	Contact Hours
1.	<b>Introduction to Ecology:</b> Relevance of studying ecology, its history, autecology, synecology, Species (Sympatric and Allopatric).	8
2.	<b>Ecosystem, Biome, Biosphere and Ecosphere:</b> Abiotic Factors, Laws of limiting factors- Liebig's law of minimum and Shelford's law of tolerance.	9
3.	<b>Population &amp; its growth:</b> Ecosystem, Community, Sustainable development, Biodiversity, Trophic levels, Nutrient cycles.	9
4.	<b>Introduction to Evolution:</b> Lamarckism, Darwinism, Neo-Darwinism, An overview (chemogeny, biogeny, the RNA World).	8

5.	<b>Process and products of evolutionary change:</b> (Population genetics, Natural selection, Species concept and modes of speciation.	8
TOTAL		42

**Books: -**

S. No.	Name of Books/ Author/Publisher
1	Environmental studies Benny Joseph-Tata Mc Graw Hill
2	Rana. S.V.S., —Essentials of Ecology & Environment Science, PHI Publications.
3	Ridley, M. Evolution. III Edition. Blackwell Publishing
4	Barton, N. H., Briggs, D.E.G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. Evolution. Cold Spring Harbour Laboratory Press
5	Hall, B.K. and Hallgrimsson, B. Evolution. IV Edition. Jones and Bartlett Publishers

Transgenic Technology

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Transgenic Technology (BT314)</b>	3	1	0	NIL

**Course Objective:**

This course describes the methodology for generation of transformants and applications of transgenics.

**Course Outcome:**

- 1 Compare different types of vectors –bacterial, plant and animal and the method of transformation of vectors.
- 2 Discuss nuclear transfer, therapeutic cloning, gene targeting and their application.
- 3 Outline the production of recombinant biopharmaceuticals, learning improved production of alcohol, fructose and glycerol.
- 4 Discuss transgenic technology in plant and agriculture and list the applications, developing plants with improved quality.
- 5 List biosafety guidelines for the recombinant DNA, and implementation of this by national regulatory mechanism for handling GMOs.

S. No.	Content	Contact Hours
1.	<b>Basics of Recombinant DNA Technology:</b> Bacterial, plant and animal vectors; Methods of bacterial, plant and animal transformation	8
2.	<b>Techniques Related to Generation and Applications of Transgenics:</b> Nuclear transfer technologies; Reproductive and therapeutic cloning; Gene therapy; Gene targeting; Gene editing; Use of recombinase in transgenic construction; Application of Cre recombinase, Flippase, Zinc finger nucleases and Transcription activator-like effector nuclease; Recombinase mediated gene stacking; Design of vectors for optimizing transgene expression; Analysis of phenotype and transgene expression; Databases	8
3.	<b>Recombinant Microorganisms:</b> Production of recombinant biopharmaceuticals, restriction enzymes, antibiotics, Small molecules, biopolymers, recombinant vaccines; Biopesticides; Improved production of alcohol, fructose, glycerol; Improved conversion of glucose to fructose; Efficient utilization of cellulose; Plant growth promotion; Bioremediation, Superbug	9
4.	<b>Plant and Animal Transgenics:</b> Plant transgenics: Applications of transgenic technology in agriculture; Development of plants with improved quality attributes; Phytoremediation; Bioenergy plants; Plants as bioreactors; Edible vaccines; Animal transgenics: Application as basic research models and bioreactors; Application in molecular pharming, DNA vaccines, human gene medicines; stem cell therapy	9
5.	<b>Regulation and Public Concerns:</b> Recombinant DNA biosafety guidelines; National regulatory mechanism for implementation of biosafety guidelines for handling GMOs; Commercialization; Public acceptance; Risk factors related to transgenic plants and animals – health, environmental, ecological, socio-economical safety and ethical issues; Bt cotton case study; Concerns and regulations related to stem cell research and human cloning	8
TOTAL		42

**Books: -**

S. No.	Name of Books/ Author/Publisher
1	Molecular Biotechnology by Glick, B.R. and Pasternak, ASM Press, USA
2	Molecular Cloning: A Laboratory Manual (3 Volume Set) by J. Sambrook and David W. Russel. Third edition. Cold Spring Harbor Laboratory Press
3	Genetic Engineering by Rastogi, S. and Pathak, N. Oxford University Press
4	Principles of Gene Manipulation and Genomics Primrose, S.B. and Twymann, R.

5	Understanding DNA and Gene Cloning: A Guide for the Curious by Drlica, K. 4TH Ed. Wiley
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### Bioenergy and Biofuels

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Bioenergy and Biofuels(BT316)</b>	3	1	0	Nil

<p><b>Course Objective:</b> To impart basic understanding of renewable energy resources</p>
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<p><b>Course Outcome:</b></p> <ol style="list-style-type: none"> <li>1. Discuss biofuels production process, importance and knowing status of research in India.</li> <li>2. Summarize process technology for bioethanol production using sugars, starch, and lignocellulose.</li> <li>3. Identify lipids as a source of biodiesel its methods of production from microalgae and future prospect.</li> <li>4. Discuss the production of biohydrogen by anaerobic bacteria and photosynthetic algae, also about the factors affecting it.</li> <li>5. Explain microbial fuel cell development their design and performance.</li> </ol>
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S. No.	Content	Contact Hours
1.	<b>Introduction to Biofuels:</b> Global energy outlook,,Biofuel Production Process and technology, ; Importance of biofuel feed stocks; Cellulose, starch, sugar, Lignocellulosic, Agro and Industrial by-products, Current status of research in India.	8
2.	<b>Production of Bio-ethanol:</b> Process Technology for Bioethanol production using Sugar; Starch and Lignocellulosic. Selection of micro-organisms and raw materials; Unit Operations in Alcohol production.	9
3.	<b>Production of Biodiesel:</b> Lipids as a source of biodiesel; Methods of Biodiesel Production, Quality Control Aspects. Biodiesel production from microalgae and future prospects	9
4.	<b>Production of Biohydrogen: Biohydrogen</b> Production by anaerobic bacteria and photosynthetic algae, Enzymes involved in biohydrogen	8

	production, Factors affecting biohydrogen production, Detection and Quantification of biohydrogen.	
5.	<b>Microbial Fuel Cells:</b> Introduction and biochemical basis, History of microbial fuel cell development, Microbes used in microbial fuel cells Design of microbial fuel cells; MFC components, Two and Single MFC systems, Performances of microbial fuel cells.	8
TOTAL		42

**Books: -**

S. No.	Name of Books/ Author/Publisher
1	Caye M. Drapcho, N.P. Nhuan and T. H. Walker, Biofuels Engineering Process Technology, Mc Graw Hill Publishers, New York,
2	Jonathan R.M, Biofuels – Methods and Protocols (Methods in Molecular Biology Series), Humana Press, New York,
3	Lisbeth Olsson (Ed.), Biofuels (Advances in Biochemical Engineering/Biotechnology Series, Springer-Verlag Publishers, Berlin,.

### Enzymology and Enzyme Technology

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Enzymology and Enzyme Technology (BT318)</b>	3	0	2	NIL

**Course Objective:**

To integrate the practical aspects of enzymology with the kinetic theories and provide a mechanistic overview of enzyme activity.

**Course Outcome:**

1. Understand the concept of Enzyme, its application.
2. Illustrate the kinetics and mechanism of Enzyme
3. Compare and contrast the types of Enzyme Immobilization.
4. Identify the Enzyme Reactor for Batch/ continuous enzymatic processing.
5. Analyze the Bioprocess Design and Physical parameters.

S. No.	Content	Contact Hours
1.	Enzyme: Introduction and scope, Nomenclature, Application of enzyme, Enzyme catalysis in organic media.	8
2.	Enzyme Kinetics: Kinetics of enzymatic reaction, Single and multiple substrate systems, Inhibition - substrate, product and inhibitors, Mechanism of enzyme action.	8
3.	Immobilization of Enzyme: Methods of immobilization External and diffusional mass transfer limitation, Effectiveness factor.	9
4.	Enzyme Reactor: Reactors for Batch/ continuous enzymatic processing, choice of reactor type.	9
5.	Bioprocess Design: Physical parameters, immobilized cells.	8
TOTAL		42

**Books: -**

S. No.	Name of Books/ Author/Publisher
1	Fundamentals of Enzymology by Price and Stevens. Publisher: Oxford University Press.
2	Introduction to Biocatalysis using Enzymes and Microorganisms by S.M. Roberts, N.J. Turner and A. J. Willetts. Publisher: Cambridge University Press
3	Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady - State Enzyme Systems by I.H. Segel. Publisher: Wiley-Interscience.
4	Enzyme Technology by M.F. Chaplin and C. Bucke. Publisher: Cambridge University Press
5	Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis by R.A. Copeland .Publisher: John Wiley and Sons Inc

**Protein Engineering****Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Protein Engineering (BT320)</b>	3	1	0	Nil

**Course Objective:**

To impart advance knowledge on how to engineer proteins through a detailed study of protein structure, its characteristic properties and its significance in biological Systems.

**Course Outcome:**

1. Compare and contrast between different types of bonds in protein structure.
2. Understand amino acid structure, their molecular properties and chemical reactivity.
3. Analyze and determine structure of protein
4. To know the relationship between structure and function of DNA binding proteins
5. Identify and analyze protein by 2D analysis, Mass Spectrometry.

S. No.	Content	Contact Hours
1.	<b>Bonds and Energies in protein:</b> Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure.	8
2.	<b>Amino acids and their characteristics:</b> Amino acids- structure with three and single letter codes, molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification.	8
3.	<b>Protein architecture:</b> Primary structure- peptide sequencing, Secondary structure- methods to determine Tertiary structure-overview of methods to determine 3D structures.	8
4.	<b>Structure-function relationship:</b> DNA binding proteins- Prokaryotic transcription factors, Eukaryotic transcription factors, Membrane proteins.	9
5.	<b>Identification and analysis of proteins:</b> Identification and analysis of proteins by 2D analysis, Mass spectrometry- ion source (MALDI, spray sources), analyser and detector.	9

TOTAL	42
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**Books: -**

S. No.	Name of Books/ Author/Publisher
1	Lehninger's Principle of Biochemistry by DL Nelson, MM Cox. Publisher: WH Freeman
2	Biochemistry by D Voet, JG Voet. Publisher: Wiley
3	Biochemistry by CK Mathews, KE Van Holde, KG Ahern. Publisher: Benjamin/Cummings
4	Biochemistry by L Stryer. Publisher: WH Freeman and Company

**Technological applications in Food technology**

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Technological applications in Food technology (BT322)</b>	3	1	0	NIL

**Course Objective:**

Introduction to Biotechnology integrates the fundamental concepts of life and physical sciences together with the basic laboratory skills necessary in the biological sciences. It provides foundational concepts in a broad spectrum of disciplines such as biochemistry, genetic engineering, biophysics, microbiology, molecular and cell biology.

**Course Outcome:**

1. Compare and contrast material science by learning its properties, classification, crystal geometry. Structure determination by X-ray Diffraction- Crystalline and Non-crystalline.
2. Gain in depth knowledge of food technology and its various aspects.
3. Analyze different types of chromatography, learning their principles and applying different techniques of chromatography in food analysis.
4. Distinguish different methods of manufacture of various foods, fruits and vegetables also learning basics of preservation treatments of food.
5. Design food packaging in detail by learning testing of packaging, effect of environmental factors on packaging and Vacuum Packaging

S. No.	Content	Contact Hours
1.	<b>Material science and food technology</b> -Properties of Crystals and Solids : Classification of Engineering materials –Crystal geometry– Structure determination by X-ray Diffraction- Crystalline and Non-crystalline states – Inorganic solids – Metals and Alloys - Imperfection in Crystals and Phase diagram – Iron-Iron carbide systems and applications – Fick’s second law of diffusion and its importance in alloy manufacture – Phase transformations and its applications –Manufacture and properties of different types of steel – Basics of SS Fabrication – Deformations – Creep, Fatigue, and Fracture – Oxidation and Corrosion and methods of protection	8
2.	<b>Agitation and mixing agitated vessels-</b> mixing and blending of miscible liquids, mixing index and effectiveness of mixing. Types of evaporators, single and multiple effect evaporators. Evaporator capacity, multiple effect evaporator – methods of feeding. Moisture and its measurements. Drying rate – Mechanical Drying. Types fixed – and Fluidized Bed. Filtration – types of filtration, constant pressure filtration and constant volume filtration and filtration aids. Principles of comminution. Energy and power requirements. Size reduction equipments.	8
3.	<b>Chromatography principles.</b> High performance liquid chromatography, Gas chromatograph - column efficiency, types of detectors – FID, TCD, ECD, MSD. FTIR Spectroscopy. Atomic Absorption Spectroscopy and Atomic Emission Spectrometry (AES). ICP – Mass spectrometry - Atomic Fluorescence Spectrometry (AFS). The NMR Phenomenon – Types of information provided by NMR spectra – Instrumental and Experimental Considerations – Solid state NMR – application of NMR to Food analysis. Application of GC/MS, LC/MS / FAB/MS / MS/MS and linked scan techniques for food analyze.	8
4.	<b>Technology of Rice, Pulse milling and Wheat Milling-</b> Oil extraction- Methods of manufacture of bread-Fruits and vegetable processing - Preservation treatments-Basics of Canning, Minimal processing and	9

	Hurdle technology. Processing of fruit juices. Dairy processing-manufacture of milk and milk products - Meat, poultry and fish processing and their products- Processing of Plantation products - Processing of Tea, Coffee and Cocoa and chocolate Processing of spices-. Pepper, cardamom, ginger, vanilla and turmeric.	
5.	<b>Introduction to Food packaging</b> , Effect of environmental factors in packaging, testing of packaging materials, Shelf-Life Estimation, Vacuum Packaging, Manufacturing of Metal cans, glass containers, plastic containers and pouches, paper and paperboard. Properties of plastics, Filling and sealing of Flexible plastic containers, Form fill Seal equipment: Printing on packages, Bar codes, Nutrition labeling and legislative requirements Extrusion – Retort pouch packaging, Active packaging, Moisture control, CO2 and Oxygen scavenging, Modified atmosphere packaging – principles, applications	9
TOTAL		42

**Books: -**

S. No.	Name of Books/ Author/Publisher
1	Rajput R.K., Fundamentals of Materials Science, S.K. Kataria and Sons, Mittemeijer, Eric J., Fundamentals of Materials Science,
2	Singh and Heldman, “Introduction to Food Engineering” Academic Press,
3	Coles, R., Dowell, D.M., Kirwan, J. “Food Packaging Technology”, Wiley-Blackwell Publishing Ltd,
4	The History and Future of the World Trade Organization, WTO Publications, Craig Van Grasstek, 2..
5	Guide to the Food Safety and Standards Act. Tax-mann allied Services Pvt. Ltd., ISBN –

## Medical Microbiology

### Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Medical Microbiology (BT324)</b>	3	1	0	NIL

### Course Objective:

To impart basic understanding of human pathogens and medical microbiology

### Course Outcome:

1. Enlist various bacteria, microorganism like staphylococcus, streptococcus, pneumococcus, vibrio
2. Summarize life cycle, morphology, disease, and lab diagnosis of various protozoans and nemato
3. Define morphology, diseases and lab diagnosis of many virus pathogens.
4. Analyze morphology, structure, classification of fungi and learning its process of nutrition cultivation.
5. Apply medical knowledge in microbiology to know about urinary tract infection, nosoco infections, and introduction to immunization.

S. No.	Content	Contact Hours
1.	<b>Systemmic Bacteriology:</b> Study of - Staphylococcus, Streptococcus, Pneumococcus, Neisseira gonorrhoea, Neisseira meningitis, Cornybacterium diptheriae, Mycobaterium, Clostridium, E. coli, H. pylori, Klebsiella, Salmonella, Proteus, Pseudomonas, Vibrio & Spirochaetes	9
2.	<b>Parasitology:</b> Protozoa: Intestinal Amoebae a. E. Histolytica, Flagellates of intestine/genitalia a. Giardia lamblia, Trichomonas vaginalis, Malarial Parasite, Plasmodium vivax, P. malaria, P. falcipaum & P.ovale, Nematodes: Life cycle, Morphology, disease & lab diagnosis	8
3.	<b>Virology:</b> Viral pathogens Morphology, disease & lab diagnosis	8

4.	<b>Mycology:</b> Morphology and structure of fungi. - Classification of fungi. - Nutrition and cultivation of fungus. - Cutaneous & Sub cutaneous and Systemic Mycosis. 14 - Lab diagnosis of fungal Infections. - Opportunistic fungal infections.	8
5.	<b>Applied Medical Microbiology:</b> Urinary tract infections, Nosocomial infections, Pyrexia of unknown origin, Immunization, Automation - Introduction, meaning, advantages, history	9
TOTAL		42

**Books: -**

S. No.	Name of Books/ Author/Publisher
1	Medical Microbiology 7 <sup>th</sup> ed Murray, Rosenthal, Pfaller
2	Medical Microbiology, 4th edition ISBN-10: 0-9631172-1-1
3	<a href="#">Polymicrobial Diseases</a> , Brogden KA, Guthmiller JM Washington (DC): ASM Press
4	Prescott's Microbiology 9 <sup>th</sup> ed. <b>Joanne Willey, Linda Sherwood and Christopher J. Woolverton</b>
5	Topley and Wilson's Microbiology and microbial infections, 10 <sup>th</sup> ed

## Industrial Biotechnology

### Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Industrial Biotechnology (BT326)</b>	3	1	0	NIL

### Course Objective:

The objective is to develop biotechnology approaches with the exploitation of enzymes, microorganisms, and plants that will yield 'green' industrial processes that are cost effective and sustainable.

### Course Outcome (CO):

1. Outline the basic concepts of fermentation, upstream and downstream processes.
2. Summarize the production of primary metabolites like organic acid Amino acids and alcohols and production of secondary metabolites like Antibiotics, Vitamins and Steroids.
3. Illustrate production of industrial enzymes, Biopesticides, Biofertilizers, and Biopreservatives
4. Explain production of modern biotechnology products like recombinant proteins, vaccines.

S.No.	Content	Contact Hours
1.	<b>Introduction to industrial bioprocess:</b> Fermentation, Basic concepts of Upstream and Downstream processes	<b>9</b>
2.	<b>Production of primary metabolites:</b> Organic acids, Amino acids and alcohols.	<b>8</b>
3.	<b>Production of secondary metabolites:</b> Antibiotics, Vitamins and Steroids	<b>8</b>
4.	<b>Production of enzymes and other bioproducts:</b> Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation.	<b>9</b>
5.	<b>Production of modern biotechnology products:</b> Production of recombinant proteins, vaccines.	<b>8</b>
<b>TOTAL</b>		<b>42</b>

### Books:-

S.No.	Name of Books/ Author/Publisher
1.	Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd.
2.	Balasubramanian, D. et al., "Concepts in Biotechnology" Universities Press Pvt.Ltd.
3.	Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" 2 nd Edition Cambridge University Press.
4.	Dubey, R.C. "A Textbook of Biotechnology" S.Chand & Co. Ltd.
5.	Kumar, H.D. "A Textbook on Biotechnology" 2 nd Edition. Affiliated East West Press Pvt. Ltd.

### Concepts in Neurobiology

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Concepts in Neurobiology (BT328)</b>	3	1	0	NIL

**Course Objective:**

To impart understanding of neuroscience

**Course Outcome (CO):**

1. Explain the working of the nervous system, its membrane and action potential while also learning its development and neurogenesis.
2. Distinguish the nervous system into central and peripheral nervous system.
3. Define the movement, memory and learning of the neural control system.
4. Discuss various network of neuroendocrine –immune system and homeostatis.
5. Outline new approaches which can be used in neuroscience.

S.No.	Content	Contact Hours
1	<b>Introduction to neuroscience</b> Introduction to Nervous system-Neurons and glia-Membrane potential - Action potential -Development of nervous system-Neurogenesis	8
2	<b>Neurochemicals and sensory nervous system</b> Divisions of the nervous system—Central and peripheral nervous systems, Neurotransmitters-Amino acids-Neuropeptides—Sensation and perception, Vision-Hearing and equilibrium-Taste and Smell-Body senses	8
3	<b>Neural control of movement, memory, and learning</b> Movement—Anatomy and physiology of the neuromuscular junction—Nervous system control of movement—Basal Ganglia—Cerebellum—Motor neurons— Spinal reflexes-Learning and Memory	9
4	<b>Neuroendocrine-immune network and homeostasis</b> Emotions and reward systems—Neuroanatomy of emotions—Reward mechanisms—Neuroendocrine and Immune network—Hypothalamus and endocrine system	8
5	<b>Neurodegenerative diseases</b> Sleep and wakefulness—Arousal and wakefulness—Types and stages of sleep and memory—Diseases of injuries of the nervous system—Neuromuscular disorders-Basal ganglia disorders—Spinal cord injury—Traumatic brain injury—Stroke—Dementia	9
TOTAL		42

**Books:-**

S.No.	Name of Books/ Author/Publisher
1	Handbook of Neurology Minoru Oishi

2	Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, "Principles of Neural Science," McGraw-Hill, 5th Edition
3	Robert Ader, "Psychoneuroimmunology," Academic Press; 4th edition
4	Memory Mechanisms in Health and Disease

### Bioinformatic Approaches in Complex disorders

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Bioinformatic Approaches in Complex disorders (BT330)</b>	3	1	0	Nil

**Course Objective:**

This course focuses on analyses, chemistry, processing, bioavailability, and health benefits of bioactive food components. Objective of the course is to understand fundamental concepts and knowledge related to functional food and to reveal to students the importance of food in the promotion of our health.

**Course Outcome:**

1. Gain proficiency in using bioinformatics tools and software to analyze complex genetic data.
2. Develop the ability to interpret genetic variations and their associations with complex disorders.
3. Learn how to integrate multi-omics data (e.g., genomics, transcriptomics, proteomics) for comprehensive disorder analysis.
4. Apply computational methods to identify biomarkers and potential therapeutic targets for complex disorders.
5. Enhance skills in critically analyzing and interpreting bioinformatic research studies related to complex disorders.

S. No.	Content	Contact Hours
1.	<b>Introduction:</b> Monogenic and complex disorders; Interplay of genetic and environmental Factors; Integration of clinical and molecular data; Understanding the factors influencing disease susceptibility	9
2.	<b>Genome wide sequence extraction:</b> Genomic sequences; Genome analysis; Extraction of information related to length of the sequence, organism specificity, evolutionary origin, etc	8

3.	<b>Database Creation:</b> Database system; Construction of database; Database interface; Data collection and retrieval; Database Management Systems; Importance of databases and database management systems	8
4.	<b>Sequence based and Structure based analysis:</b> Sequence alignment and assembly; Profile comparison of sequences; Similarity search and conserved domains; Identification of intrinsic features of the sequence and its variations, Identification of molecular structure; Structure induced functional analysis; Exploring genetic diversity.	8
5.	<b>Development of a Predicted Tool:</b> Features of predicted tools and why need them; Data utility; Statistical algorithms; Machine learning techniques; Types of predictive tools	9
TOTAL		42

Books: -

S. No.	Name of Books/ Author/Publisher
1	Shui Qing Ye 2015: Big Data Analysis for Bioinformatics and Biomedical Discoveries by Chapman and Hall/CRC, 2015
2	Eija Korpelainen, Jarno Tuimala, Panu Somervuo, Mikael Huss, Garry Wong 2014: RNA-seq Data Analysis: A Practical Approach by Chapman & Hall/CRC Mathematical and Computational Biology, 2014
3	Robert Gentleman: 2008 R Programming for Bioinformatics by Chapman and Hall/ CRC, 2008
4	Bentley DR, Balasubramanian S, Swerdlow HP, et al. Accurate whole human genome sequencing using reversible terminator chemistry. Nature. 2008; 456:53- 59, 2008

### Plant Bioinformatics

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Plant Bioinformatics (BT332)</b>	3	1	0	NIL

**Course Objective:**

Plant Bioinformatics studies pave the way to understand plant evolution, and use this knowledge to improve crops. Plant Bioinformatics carries benefits for plant researchers. It can aid in plant breeding and genetic engineering, and allow plant scientists to produce better crops for the future.

**Courses Outcome:-s**

1. Outline importance of plant bioinformatics, protein and Gene Information Resources PIR, SWISSPROT, PDB, genbank
2. Describe plant specific genomic data and resources like HarvEST, TARI database, legume resources, GrainGenes, Maize GDB, Gramene
3. Find software used to discover phylogenies their use and status of specimen data, also learning the current priorities in biodiversity informatics its challenges and future prospect
4. Explain KEGG Bioinformatic Resource for Plant Genomic Research its tools, Resources and management system
5. Apply annotation gene ontology, manual and computational annotation on plants using several plant GDB resources

S.No.	Content	Contact Hours
1	<b>Introduction to Plant Bioinformatics: Importance of plant bioinformatics</b> , biological databases , Protein and Gene Information Resources – PIR, SWISSPROT, PDB, genbank.	8
2	<b>Plant specific Genomic Data and Resources:</b> HarvEST, TARI Database, Legume Resources, GrainGenes, Maize GDB, Gramene	8
3	<b>Phylogenetic data and phylogenies</b> Software used to discover phylogenies, use and status of specimen data, species distribution, Current priorities in biodiversity informatics, challenges and future prospect	9
4	<b>KEGG Bioinformatic Resource for Plant Genomic Research:</b> KEGG tools and Resources, Germplasm Data Management Arlet Portugal, Ranjan Balachand	9
5	<b>Gene Structure Annotation at Plant GDB:</b> PlantGDB Resources, Gene Ontology Annotation, Manual Annotations, Computational Annotation Methods	8
<b>Total</b>		<b>42</b>

**Books: -**

<b>S.No.</b>	<b>Name of Books/ Author/Publisher</b>
1.	Plant Genomics: Methods and Protocols, Daryl J. Somers, Peter Langridge and J. Perry Gustafson, Humana Press, 2009.
2.	Plant Genomics and Proteomics, CHRISTOPHER A. CULLIS, John Wiley & Sons, Inc. 2004s
3.	Plant Bioinformatics: Methods and Protocols, David Edwards, Humana Press, 2007.

## Biomaterials

### Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Biomaterials (BT334)</b>	3	1	0	NIL

### Course Objective:

To study the structure and characteristics of different types of biomaterials of natural and synthetic origin. This course will give an idea on the effective uses of these materials in medical science.

### Course Outcome (CO):

1. Differentiate various metallic implant material like stainless steel Co-based alloys, Ti-based alloys and their corrosion behaviour

2. Differentiate various metallic implant material like stainless steel Co-based alloys, Ti-based alloys and their corrosion behaviour

3. Distinguish between different types of bioceramics, composite implant materials and learning mechanics of improvement of properties by incorporating different elements.

4. Classify of different polymeric implant material, and describing use of biodegradable polymers for medical purposes

5. Interpret the biocompatibility of biomaterials by methods like blood compatibility Toxicity tests and In-vitro and In-vivo testing

S.No.	Content	Contact Hours
1	<b>Introduction:</b> Definition, requirements of biomaterials, Comparison of properties of some common biomaterials, effects of physiological fluid, biological responses, physical and surface properties.	8
2	<b>Metallic implant materials:</b> Stainless steel- Co-based alloys- Ti and Ti-based alloys, corrosion behaviour, Hard tissue and soft tissue replacement implant.	8
3	<b>Ceramic and composite implant materials:</b> Types of bioceramics, Importance of wear resistance, Composite implant materials- Mechanics of improvement of properties by incorporating different elements.	8
4	<b>Polymeric implant materials:</b> Classification, Viscoelastic behaviour, Biodegradable polymers for medical purposes, Synthetic polymeric membranes and their biological applications.	9

5	<b>Testing of Biomaterials:</b> Biocompatibility, blood compatibility Toxicity tests, <i>In-vitro</i> and <i>In-vivo</i> testing.	9
<b>Total</b>		42

**Books:-**

S.No.	Name of Books/ Author/Publisher
1.	S. V. Bhat. Biomaterials, Springer.
2.	J.B. Parkand, JD Boonzino. Biomaterials: Principles and Application, CRC Press.
3.	J. Black. Biological Performance of materials, Taylor & Francis.
4.	J. B. Parkand, R. S. Lakes. An Introduction to Biomaterials, Springer.
5.	B. D. Ratner, F. J. Schoen, A. S. Hoffman, J. E. Lemons. Biomaterials Science: An introduction to Materials in medicine, Academic Press.

**Nanobiotechnology and Nano biomedicine**

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Nanobiotechnology and Nanobiomedicine (336)</b>	3	0	2	NIL

Course Objective:

To establish careers in their branch of study, ie., Nanotechnology or Nanomedicine, or the interdisciplinary and multidisciplinary fields.

Course Outcome (CO):

1. To understand the basic principles of nanosciences
2. Illustrate the various synthesis and characterization methods.
3. To explain the various types of nanomaterials and their potential application in diagnosis and therapy

4. To provide the details of biosensors and their application
5. Understanding the nanotoxicology and its management.

S.No.	Content	Contact Hours
1	Introduction to Nanobiotechnology, basic principles of nanoscience.	8
2	Synthesis and characterization of nanomaterials, Top-down and Bottom-up approach for nano synthesis. characterizing nanomaterials for their morphology, structure, chemistry, and functionality through diverse methods of microscopy, spectroscopy	12
3	Types of nanomaterials and application in medicine. QDs, Dendrimers, inorganic and organic nanoparticles, carbon nanotubes liposomes, nanopore, drug delivery applications in diagnosis and therapy, Nano biomaterials, interface of tissue and nano biomaterials, Lab-on-a-Chip	10
4	<b>Biosensors:</b> Introduction to biosensors, the biological component, the sensor surface, Immobilization of the sensor molecule, Applications of molecular recognition elements in nanosensing of different analytes, Application of various transducing elements as part of nano biosensors	6
5	<b>Nanotoxicology:</b> Principles of toxicology; toxicology models, experimental toxicology studies; activation and detoxification mechanisms.	6
		42

**Books:**

S.No	Name of Book/Author/Publisher
1	Nanobiotechnology: Concepts, Applications and Perspectives, Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2	Nanobiotechnology - II more concepts and applications, Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
3	Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.
4	D.S. Goodsell, Bionanotechnology: Lessons from Nature, Wiley Press
5	G. Ozin, A. Arsenault, Nanochemistry. A Chemical Approach to Nanomaterials, RSC, London

**Biomaterials and clinical devices**

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Biomaterials and clinical devices (338)</b>	3	0	2	NIL

**Course Objective:**

To introduce students to the fundamental principles of biomaterials science, including the properties, classification, and applications of different types of biomaterials used in medical devices.

**Course Outcome (CO):**

1. To explore the interactions between biomaterials and biological systems, focusing on biocompatibility, bioactivity, and the body's response to implanted materials.
2. To provide knowledge on the design, fabrication, and testing of clinical devices using biomaterials, considering factors such as mechanical properties, degradation, and sterilization techniques.
3. To understand the regulatory and ethical considerations in the development and use of biomaterials and clinical devices, including standards, approval processes, and clinical trials.
4. To examine current trends and innovations in biomaterials and clinical devices, including the use of advanced materials, nanotechnology, and tissue engineering.

S.No.	Content	Contact Hours
1	Introduction: Definition of biomaterial, requirements of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.	8
2	Metallic implant materials: Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with biometal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.	9
3	Polymeric implant materials: Polyolefins, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetals. (Classification according to thermosets, thermoplastics and elastomers). Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for 8medical purposes,	8

	Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.	
4	Biocompatibility & toxicological screening of biomaterials: Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.	8
5	Testing of biomaterials/Implants: In vitro testing (Mechanical testing): tensile, compression, wears, fatigue, corrosion studies and fracture toughness. In-vivo testing (animals): biological performance of implants. Ex-vivo testing: in vitro testing simulating the in vivo conditions. Standards of implant materials	9
<b>Total</b>		42

#### Books :-

S.No.	Name of Books/ Author/Publisher
1.	Jonathan Black, Biological Performance of materials, Marcel Decker, 1981
2.	Eugene D. Goldbera , Biomedical Ploymers, Akio Nakajima.
3.	A. Rembaum & M. Shen, Biomedical Polymers, Mercer Dekkar Inc. 1971
4.	Lawrence Stark & Gyan Agarwal , Biomaterials
5.	L. Hench & E. C. Ethridge, Biomaterials - An Interfacial approach.

#### Basic Epidemiology

##### Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Basic Epidemiology (BT340)</b>	3	0	2	NIL

##### Course Objective:

To provide a foundational understanding of the principles and concepts of epidemiology, including the study of the distribution and determinants of health-related states or events in specific populations.

**Course Outcome (CO):**

1. To demonstrate a solid understanding of basic epidemiological concepts and terminology, including incidence, prevalence, morbidity, and mortality.
2. Students will be able to apply epidemiological methods to analyze the distribution and determinants of health-related events, effectively using statistical tools and techniques.
3. To develop the ability to critically evaluate and interpret epidemiological data and research findings, assessing the validity and reliability of studies.
4. Students will be able to apply epidemiological knowledge to design, implement, and evaluate public health interventions, contributing to the control and prevention of diseases.
5. Students will understand the ethical considerations in conducting epidemiological research and practice, ensuring adherence to ethical standards in their professional activities.

S.No.	Content	Contact Hours
1	Definitions of epidemiology - Epidemiology in Public Health- Natural history of disease - Historical aspects of Epidemiology - Common risk factors- Tools of Epidemiology- Measures of Disease, Risk Rates, Descriptive Epidemiology, Measuring infectivity, Survey methodology including census procedures, Surveillance, outbreak investigation in public health & contact investigation	8
2	Epidemiological study designs, Bias, confounding and interaction, Causal association, Disease Surveillance	9
3	Research Question, Study Designs, Literature Retrieval, Organising Literature, Critical Appraisal, Diagnostic tests, Measurement issues qualitative research.	9
4	Mixed designs- Statistical support to epidemiology (Sample selection, Sample size), Tools, Bias, Outcome measures, Analysis and reporting, Research Ethics.	8
5	Containing the Spread of Epidemics, The Surveillance of Communicable Diseases, Quarantine: Spatial Strategies, Vaccination: Interrupting Spatial Disease Transmission, Eradication, Intervention: Modelling, Demographic Impact and the Public Health	8
Total		42

**Books:-**

S.No.	Name of Books/ Author/Publisher
1.	Gordis Leon. Epidemiology (Fifth edition) , Elsevier Saunders, 2013.
2.	Dona Schneider and David E. Lilienfeld. Lilienfeld's Foundations of Epidemiology, Fourth Edition, Oxford University Press, USA, 2015.

3.	Porta Miquel. A Dictionary of Epidemiology, Oxford University Press, USA, 2014
4.	Somerville Margaret, et al., Public Health and Epidemiology at a Glance, Second Edition, Wiley-Blackwell, 2016
5.	Beaglehole. R. Bonita, et. al Basic Epidemiology, 2nd Edition, WHO Publication, Geneva, 2006.

### Biodiversity and Bio-resource Planning

**Details of course :-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Biodiversity and Bio-resource Planning (BT342)</b>	3	0	2	NIL

**Course Objective:**

The curriculum gives holistic coverage to the extremely valuable field of Biodiversity. Biodiversity—the variety of genes, species, and ecosystems—is the basis for long-term ecosystem health and stability. The world’s biodiversity is diminishing and dwindling before our eyes at an alarming rate day by day. Half of the world’s wetlands have been lost in the past century; 80 percent of grasslands are suffering from soil degradation; and 20 percent of drylands are in danger of becoming deserts.

**Course Outcome (CO):**

1. Discuss biodiversity different aspects like agriculture and animal flora and fauna , factors affecting biodiversity changes
2. Outline roles of plants, microbes and animal in natural ecosystems and life supports also importance of traditional cultivators and wild species in agriculture
3. Discuss management of agro-biodiveristy, human animal conflict and its impact on distribution and consequences.
4. List uses and applications of animal, domestick livestock. Also primay and secondary metabolite from plants animals and microbes.
5. Discuss international conventions, national laws policies, action plans and treaties for conservtions of forest, wildlife, biodiversity and oher bioresources

S.No.	Content	Contact Hours
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1.	<b>INTRODUCTION TO BIODIVERSITY</b> Man – nature interactions, Role of bioresources in shaping human culture. Agriculture and Animal Husbandry- Origin, Spread, Changes, Challenges; Resource Use Patterns – Diversity, Specificity, Sustainable utilization of bioresources; Biodiversity, components, scope, and constraints of biodiversity, genetic diversity, species diversity, ecosystem diversity – aquatic biodiversity, agro-biodiversity, urban-peri-urban biodiversity, forest biodiversity; Wealth of India: Flora & Fauna with respect to western Ghats, Himalayan and sub-Himalayan regions, Freshwater and marine water biodiversity in India; biodiversity indices, Role of biodiversity in ecology and natural balance, threats to biodiversity. Factors affecting biodiversity changes.	8
2.	<b>RESOURCES FROM PLANT, ANIMAL &amp; MICROBES</b> Role of plants, animals and microbes in natural ecosystems and life support systems (terrestrial, freshwater and marine), wild and domesticated gene-pool; Importance of traditional cultivars and wild species in agriculture, Value of plants, animals and microbes in scientific research and technological inventions, Traditional healthcare, modern lifestyle and economy.	9
3.	<b>STRATEGIES FOR CONSERVATION OF BIODIVERSITY</b> Management of agro-biodiversity, Human Animal Conflict, Human impact on distribution, consequences, Approaches to conservation of plants and animals (in situ and ex situ)	8
4.	<b>APPLICATIONS OF BIODIVERSITY IN BIOTECHNOLOGY</b> Uses of bio resources- animal uses; food animals (terrestrial and aquatic), non-food uses of animals, domestic livestock. Primary and Secondary metabolites from plants, animals and microbes, Fatty acids, Alkaloids, Steroids, Flavonoids, Essential oils, Bioactive molecules (antimicrobials)	8
5.	<b>LAWS, ACTS AND POLICIES</b> International conventions and treaties for conservation of bio resources, National Laws, policies and action plans for conservation of forests, wildlife, biodiversity, marine resources; National Biodiversity Authority, Role of NGOs in conservation of bio-resources and people’s participation in such efforts at global, national and grassroot level.	9
TOTAL		42

**Books:-**

S.No.	Name of Books/ Author/Publisher
1.	Krishnamurthy, K.V. 2003. Textbook of Biodiversity. Science Publications.

2.	Mittermeier, R. A., N. Meyers, P.R. Gil and C. G. Mittermeier 2000. Hotspots: Earth's Biologically richest and most endangered Terrestrial Ecoregions. Cemex/ Conservation International, USA.
3.	Gaston, K. J. 1996. Biodiversity: Biology of numbers and Difference. Blackwell.

## PRINCIPLE OF IMAGING PROCESSING IN MEDICINE

### Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Principle Of Imaging Processing in Medicine(BT344)</b>	03	01	00	Nil

**Course Objective:** To understand the principle of image processing and its use in medicine.

### Course Outcome (CO):

- 1 Understanding the principles, configurations, and reconstruction techniques of CT scanners, including the evaluation of image quality and clinical applications.
- 2 Comprehend the principles of photography and radiographic film imaging, including film sensitometry, image quality factors, and special imaging techniques.
- 3 Explore the principles and techniques of image enhancement and processing in both spatial and frequency domains, including color image processing and various image formats.
- 4 Analyze the principles and specific designs of fluoroscopic and angiographic imaging systems, including digital fluoroscopy and digital subtraction angiography.
- 5 Understand the principles of radiotherapy, including dose measurement, treatment planning, and safety protocols for clinical applications.

S.No.	Content	Contact Hours
1.	<b>Computed Tomography:</b> Principle of Computed tomography Scanner configurations/generations, CT system: Scanning unit(gantry), detectors, data acquisition system, spiral CT, scanner parameters, CT Number Reconstruction techniques, Radon Transform, Filtered Back projection, Fourier Reconstruction Technique, Iterative reconstruction Technique, Image quality and artifacts, Clinical applications of CT Multi-detector computed tomography (MDCT), Flat panel detectors CT-Angiography	<b>8</b>

2.	<b>Photography and film image:</b> Principle of photography and radiographic film image, film sensitometry, information content of an image, image quality factors (resolution, contrast, noise), Special imaging techniques: Cineradiography, cinefluorography, stereoscopic radiography, magnification radiography, microradiography, neutron radiography. Basics of Image processing: Image acquisition, Processing, communication, display, Electromagnetic Spectrum, Visual perception, structure of the human eye, image formation in the eye, uniform and Non-Uniform Sampling, Quantization, Image formats Image Enhancement: Spatial Domain-Point processing techniques, histogram processing, Neighborhood processing, Frequency Domain techniques- 2D-DFT, Properties of 2 D-DFT, Low pass, High pass, Noise removal, Homomorphic filters, Basics of Color image processing	<b>8</b>
3.	Fluoroscopy and angiography: Fluoroscopic imaging system, principle, specific system design. Digital fluoroscopy-c-arm system. Digital subtraction angiography (DSA), digital subtraction programming.	<b>9</b>
4.	Radiation therapy: Radiotherapy principles, dosage data for clinical applications (ISODOSE charts), radiation therapy planning, collimators and beam direction devices, dose measurement and treatment planning, tele isotope units. Safety protocols & protection.	<b>9</b>
5.	Infra-red Imaging: Physics of thermography, Imaging systems, clinical thermography, liquid crystal thermography, Image Compression: Fundamentals of Image compression models, Lossless Compression- RLE, Huffman, LZW, Arithmetic coding techniques Lossy Compression- IGS coding, Transform coding, JPEG, Predictive Coding.	<b>8</b>
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
16.	Digital Image Processing, Gonzalez and Woods- Pearson Education
17.	Fundamentals of Digital Image Processing, A.K. Jain –P.H.I.
18.	Digital Image Processing and Analysis, Chanda Majumder- Printice Hall India.
19.	Digital Image Processing and Computer Vision, Sonka, Hlavac,Boyle- Cenage learning.
20.	Digital Image Processing, William Pratt- John Wiley

**GENOMICS AND PROTEOMICS**

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	

<b>Genomics and Proteomics (BT346)</b>	03	00	02	Nil
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**Course Objective:**

To impart knowledge of basic techniques in functional genomics, proteomics, and interact omics

**Course Outcome (CO):**

- 1 To appraise various DNA sequencing and genome editing technologies
- 2 To understand the fundamentals of transcriptomics and to appraise various gene expression profiling and knock out techniques
- 3 To comprehend genome-wide protein analysis and protein engineering techniques
- 4 To get insight into various techniques for isolation and analysis of DNA-protein and protein-protein complexes
- 5 To appraise the concept of personalized medicine based on pharmacogenomics

S.No.	Content	Contact Hours
Unit 1	<b>Tools in Genomics and Genome Editing:</b> Next Generation Sequencing techniques; Genome sequencing; DNA fingerprinting; Crispr-Cas9, ZFN, TALEN	<b>8</b>
Unit 2	<b>Transcriptomics &amp; Functional Genomics Tools:</b> Sequence alignment; Expressed Sequence Tag; Serial Analysis of Gene Expression; Total Gene Expression Analysis; DNA microarray technology; Oligonucleotide synthesis; Arabidopsis knock out strategies; Real time PCR	<b>10</b>
Unit 3	<b>Techniques in Proteomics and Protein Engineering:</b> Protein sequencing; 2D gel electrophoresis; Mass spectrometry; Protein engineering; Rational protein design, Directed evolution	<b>8</b>
Unit 4	<b>Interactomics:</b> Methods for detecting DNA-protein interactions: Chromatin immunoprecipitation assay, Gel retardation assay, DNase I footprinting, Modification interference assay, DNA pull-down assay, Microplate capture and detection assay, Reporter assays; Methods for detecting protein-protein interactions: Coimmunoprecipitation, Yeast two-hybrid system and variants, Phage display, GFP tagging, Intein splicing; TAP tagging; Protein chips; Synthetic lethal screens; Yeast genome-wide interaction studies	<b>10</b>

Unit 5	<b>Pharmacogenomics and Personalized Medicine:</b> Single nucleotide polymorphism; Principle of pharmacogenomics; Case studies for personalized medicine	9
Total		45

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Principles of Gene Manipulation and Genomics by SB Primrose. Publisher: John Wiley
2.	Proteomics Methods and Protocols by J Reinders, A Sickmann. Publishers: Humana Totowa, NJ
3.	Discovering Genomics, Proteomics and Bioinformatics by AM Campbell, LJ Heyer. Publisher: CSHL Press
4.	Functional Genomics: A Practical Approach by SP Hunt, R Livesey. Publisher: OUP
5.	Introduction to Proteomics: Tools for the New Biology by DC Liebler. Publisher: Humana Totowa, NJ
6.	Principles of Proteomics by R Twyman. Publisher: Garland Science
7.	Proteomics: From Protein Sequence to Function by S Pennington, MJ Dunn. Publisher: BIOS Scientific
8.	A Practical Approach to Microarray Data Analysis by DP Berrar, W Dubitzky, M Granzow. Publisher: Springer
9.	Introducing Proteomics: From Concepts to Sample Separation, Mass Spectroscopy and Data Analysis by J Lovric. Publisher: Willey-VCH
10.	Functional Genomics: Methods and Protocols edited by M Kaufmann, C Klinger, A Ssvlsbergh. Publisher: Humana New York, NY
11.	Genomics and Proteomics: Principles, Technologies, and Applications by D Thangadurai, J Sangeetha. Publisher: Apple Academic

### STRUCTURAL BIOLOGY

**Details of course: -**

Course Title	Course Structure			Pre-requisite
	L	T	P	
Structural Biology (BT405)	3	1	0	Nil

**Course Objective:** To understand the structures of proteins and DNA and their interactions with other molecules

**Course Outcomes (CO):**

6. To understand the native functional structure of proteins
7. To explain the underlying mechanisms of interactions of proteins with other molecules
8. To comprehend the structure of DNA
9. To understand properties of DNA with respect to temperature and covalent modification
10. To be able to explain and design proteins with desirable properties

S. No.	Content	Contact Hours
<b>Unit 1</b>	<b>Protein Architecture:</b> Amino acids: Structure and function; Primary, Secondary, Tertiary and Quaternary structures of proteins; Structure of antibody and hemoglobin; Unstructured proteins	<b>9</b>
<b>Unit 2</b>	<b>Protein-ligand Interactions:</b> Enzyme-substrate interactions: Lock and key versus handshake mechanism; Receptor-signal interactions: Activation of cell surface receptors; Protein-protein interaction motifs	<b>8</b>
<b>Unit 3</b>	<b>DNA Structure:</b> Covalent structure of DNA; Watson Crick model; Unusual structures of DNA; Variants of B-DNA	<b>9</b>
<b>Unit 4</b>	<b>DNA Properties and Interactions:</b> DNA melting and annealing, DNA methylation; DNA binding motifs	<b>8</b>
<b>Unit 5</b>	<b>Protein Engineering:</b> Methods to design of new proteins; Protein stability	<b>8</b>
	<b>Total</b>	<b>42</b>

**Books:**

S. No.	Name of Authors / Books / Publishers	Year of Publication / Reprint
1.	Essentials of Molecular Biology by Malacinski. Publisher: Jones and Bartlett Publications	2003
2.	Biochemistry by Voet and Voet. Publisher: Wiley	2010
3.	Biochemistry: The Chemical Reactions of Living Cells by Metzler. Publisher: Elsevier	2001
4.	Lewin's Gene XII by Kreb's et al. Publisher: Jones & Bartlett Learning	2017
5.	Introduction to Protein Architecture: The Structural Biology of Proteins by Lesk. Publisher: Oxford University Press	2001
7.	Molecular Biology of the Gene by Watson et al. Publisher: Pearson	2014

8.	Lehninger's Principle of Biochemistry by Nelson and Cox. Publisher: W. H. Freeman	2017
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## PRINCIPLES AND PRACTICE IN PUBLIC HEALTH

### Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Principles And Practice In Public Health (BT407)	03	01	00	Nil

**Course Objective:** To understand Public Health at national and international level

### Course Outcome (CO):

- 1 Understand the determinants of health, the principles and practices of public health, and the historical development of public health measures and disease prevention.
- 2 Analyze the epidemiological transition, sources of global health data, and the functional organization of the public health system in India.
- 3 Explore the identification of causative microbes, molecular epidemiology, host resistance to infection, and strategies for combating infectious diseases
- 4 Understand the components of planning, implementing, monitoring, and evaluating health programs, including strategic management and case studies.

S.No.	Content	Contact Hours
1	Health, its determinants and public health, The science and practice of public health, History of public health, Disease, its measures and prevention, Measures of disease in population	6
2	Global health and epidemiological transition, Sources of global health data, Functional organization of the public health system in India, Evolution of global public health initiatives: primary health care, selective primary, health care, MDGs, SDGs	8

3	Infectious Diseases: Identification of causative microbes, molecular epidemiology, host resistance to infection, pathogenicity, combating infectious diseases	8
4	Health Programs: planning, implementation, Monitoring and Evaluation Components of strategic management, case studies	10
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Oxford textbook of Public Health Ed. Roger Detels, James McEwen, Robert Beaglehole, and Heizo Tanaka Oxford University Press (OUP) 4th Edition: 2002.
2.	Public Health at the Crossroads – Achievements and Prospects. Robert Beaglehole and Ruth Bonita 2nd Edition Cambridge University Press
3.	Maxcy-Rosenau-Last Public Health & Preventive Medicine, Fourteenth Edition Ed Robert Wallace, MD, et al.
4.	Epidemiology and Management for Health Care: Sathe, et al. Popular Prakashan, Mumbai,

### REHABILITATION ENGINEERING

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Rehabilitation Engineering (BT409)	03	01	00	Nil

**Course Objective:** To Understand to Rehabilitation Engineering and its Principles

**Course Outcome (CO):**

- 1 Grasp principles of rehabilitation engineering for motor and communication disorders.
- 2 Learn fundamentals and applications of prosthetics and orthotics.
- 3 Understand sensory augmentation for visual, auditory, and tactual systems.
- 4 Explore application principles and future developments in rehabilitation engineering.
- 5 To Understand the conceptual framework

S.No.	Content	Contact Hours
1.	Introduction to Rehabilitation: Principles involved in the study of rehabilitation Engineering Rehabilitation Engineering Science and Technology Rehabilitation Engineering concepts in motor rehabilitation Engineering concepts in communication disorders.	8
2.	Orthopedic Prosthetics & Orthotics in Rehabilitation Technology Fundamentals, Applications, Summary.	8
3.	Sensory Augmentation & substitution Visual System. Auditory system. Tactual system.	9
4.	Rehabilitation Engg. Technologies: Principles of Application	9
5.	The Conceptual Framework. Education and quality assurance. Future development	8
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Biomedical Engineering Hand book Edited by Bronzino D.Joseph Publisher CRC Press (New York) Published in 1995.
2.	Hand book of B.M. Engg. by Kline Jacob Published by Academic Press (New York) Year of Publication 1988

**SYSTEM BIOLOGY**

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>System Biology (BT411)</b>	03	01	00	Nil

**Course Objective:**

To introduce the concept of systems biology an application in biomedicine

**Course Outcome (CO):**

- 1 Explain system biology and its importance in reshaping our understanding of biochemical pathways.
- 2 Analyze networking in systems biology and how perturbations affect the overall network.
- 3 Elaborate complex systems and their topological and network evolution models, differentiating between the types of biological networks.
- 4 Interpret Dynamical Systems by computation with MATLAB, and another Computational Model of the cell.
- 5 Integrated analysis of system biology by experimental design and discuss the issues of reproducibility.

S.No.	Content	Contact Hours
1.	<b>Introduction to Systems Biology</b> , Flux Balance Analysis, Metabolic Control Analysis, Metabolic Network Reconstruction, Network structure analysis, Visual Representations and Notations for Systems Biology	<b>8</b>
2.	<b>Experimental Methods in Systems Biology</b> Scope and Overview, Biological Model Systems, Experimental Perturbations, Measuring Nucleic Acids and Proteins, Deep mRNA Sequencing, Mass Spectrometry-Based Proteomics, Flow and Mass Cytometry for Single Cell Protein Levels and Cell Fate	<b>10</b>
3.	<b>Network Analysis in Systems Biology</b> Introduction to Complex Systems, Topological and Network Evolution Models, Types of Biological Networks, Data Processing and Identifying Differentially Expressed Genes, Gene Set Enrichment and Network Analyses, Deep Sequencing Data Processing and Analysis, Principal Component Analysis, Self-Organizing Maps, Network-Based Clustering and Hierarchical Clustering, Resources for Data Integration	<b>8</b>
4.	<b>Dynamical Modeling Methods for Systems Biology</b> Introduction   Computing with MATLAB, Introduction to Dynamical Systems, Bistability in Biochemical Signaling Models, Computational Modeling of the Cell Cycle	<b>8</b>
5.	<b>Integrated Analysis in Systems Biology</b> Experimental design, Issues of Reproducibility, Kinetic Modelling Approach for Drug Development	<b>8</b>
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
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1.	Fundamentals of Systems Biology: From Synthetic Circuits to Whole-cell Models Paperback – Import, 16 Feb, by Markus W. Covert (Author), CRC Press (2015)
2.	An Introduction to Systems Biology: Design Principles of Biological Circuits (Chapman & Hall/CRC Mathematical and Computational Biology), 7 Jul by Uri Alon (2006)
3.	Systems Biology 1st Edition, June, Wiley-Blackwell by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, Ralf Herwig (2009)
4.	Stochastic Modeling for Systems Biology, Chapman & Hall/CRC, by Wilkinson, D. J. (2006)

### ADVANCED BIOANALYTICAL TECHNIQUES

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Advanced Bioanalytical Techniques (BT413)</b>	03	01	00	Nil

**Course Objective:**

This course will provide insight into the development of advanced bioanalytical techniques. It will introduce students to select specific methods of bioanalytical techniques and to apply those in solving complex analytical problems in biotechnological research.

**Course Outcome (CO):**

- 1 Distinguish between different types of microscopies like confocal and fluorescence microscopy, also learning basics of SEM, TEM, atomic force microscopy and various other dynamic methods.
- 2 Outline the basics of spectroscopy by electromagnetic radiation and Spectrum, also studying interaction of Radiation with Matter including Beer –Lambert Law and other techniques.
- 3 Define X ray spectrometers in detail with its equipment's, principle and other devices which follow the same principle as X-ray absorption meter, X-ray fluorescence spectrometry.
- 4 Discuss principle and working dynamics of various hybrid techniques like GC-MS, LC-MS and ICP-MS.
- 5 List immunochemical methods like immunoassay immunodiffusion and rocket immunoelectrophoresis.

S.N o.	Content	Contact Hours
1.	<b>Advanced Imaging Techniques In Microscopy Live cell imaging, Confocal microscopy and fluorescence microscopy - High content/throughput screening - Basics of SEM and TEM &amp; Specimen preparations. Advanced EM techniques:</b>	7

	Electron tomography and Serial block face imaging using SEM – CryoEM - Methods to study interactions: FRET, FCCS and BiFC - Atomic Force Microscopy - Dynamics methods: photobleaching and activation – STED - Structured Illumination Microscopy - Multiphoton microscopy and In vivo imaging.	
2.	<p><b>Spectroscopic techniques:</b> UV – Visible Spectroscopy: Introduction; Electromagnetic Radiation and Spectrum; Interaction of Radiation with Matter; Lambert Law; Beer Law; Beer –Lambert Law; Absorption Instruments; Radiation Sources; Materials of Optical Components.</p> <p><b>Infrared Spectroscopy:</b> Introduction; Near – Middle – Far IR range of Spectrum; Basic Components of IR Spectrophotometers: Optical Null and Ratio Recording Type Spectrophotometers; NMR: Theory and Principle of NMR - Multi nuclear NMR- Analysis of spectra and Interpretations.</p> <p><b>Mass Spectrometer:</b> Principles of modern ionization methods and mass analyzers (TOF and FT-ICR), hybrid/tandem mass methods (MS-MS) and applications of MS in the analysis of drugs and macromolecules</p>	6
3.	<p><b>X Ray Spectrometers:</b> Introduction, X-ray Spectrum, Block diagram of X-ray Spectroscopy Instrument, X-ray Generating Equipment, Collimators, Monochromators. Detectors: Photographic Emulsion, Ionization Chamber, The Geiger Muller Counter, Proportional Counter, Scintillation Counter. X-ray Diffractometer, X-ray Absorption Meter. X-ray Fluorescence Spectrometry</p> <p><b>Ion Detectors:</b> Faraday Cup, Electron Multiplier, Micro Channel Plate.</p>	7
4.	<p><b>Hybrid Techniques:</b> Gas chromatography with mass spectrometric detection (GC-MS), liquid chromatography with mass spectrometric detection (LC-MS), inductively coupled plasma with mass spectrometric detection (ICP-MS). Analysis of data: <b>HPLC chromatograms.</b></p>	6
5.	<p><b>Immunochemical methods:</b> Immunoassay, Immunodiffusion, Rocket Immunoelectrophoresis. High-Throughput Next generation sequencing (HT-NGS) platforms.</p>	8
6.	<p><b>Flow Cytometer:</b> Introduction to flow cytometry- Fluorochromes and fluorescence - Readings on flow cytometry data analysis. Isoelectric focusing and 2-Dimensional polyacrylamide gel electrophoresis and their uses.</p>	8
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Robert D. Braun, 'Introduction to Instrumental Analysis', McGraw Hill, Singapore, (1987)
2.	G.W.Ewing, 'Instrumental Methods of Analysis', McGraw Hill, (1992)

3.	Skoog, D.A., Crouch, S.R., and Holler, F.J. "Principles of Instrumental Analysis", 6th edition, Brooks/Cole, USA. (2006)
4.	Keith Wilson and John Walker, "Principles and Techniques of Practical Biochemistry", 5th Edition, Cambridge University Press. (2000)
5.	Freifelder D., Physical Biochemistry, "Application to Biochemistry and Molecular Biology", 2nd Edition, W.H. Freeman & Company, San Fransisco. (1982)

## CLINICAL BIOTECHNOLOGY

### Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Clinical Biotechnology (BT415)</b>	3	0/1	2/0	Nil

### Course Objective:

To understand clinical biotechnology and diagnostics.

### Course Outcome (CO):

1.	Identify basic principles of photometry and fluorometry and understanding the water & mineral metabolism distribution of fluids in the body.
2.	Functions & assessment of Liver based on carbohydrate metabolism, Protein metabolism, lipid metabolism, measurements of serum enzyme levels, bile pigment metabolism and jaundice.
3.	Analyse and application of Immunodiffusion Techniques like radioimmunoassay & ELISA principles & applications.
4.	Outline the principle, types & applications of electrophoresis & PCR.
5.	Identify cardiac profile Pattern of Cardiac Enzymes in heart diseases.
6.	Explain principal advantage and disadvantage of different methods Different methods of Glucose and Cholesterol Estimation.

S.No.	Content	Contact Hours
1.	<b>Basic Principles:</b> Photometry and fluorometry, Water & Mineral Metabolism Distribution of fluids in the body,	7
2.	<b>Liver Functions &amp; their Assessment.</b> Based on Carbohydrate metabolism, Protein metabolism, Lipid metabolism, Measurements of serum enzyme levels, Bile pigment metabolism, Jaundice, its types and their biochemical findings. Renal Function Tests,	6

3.	<b>Immunodiffusion Techniques:</b> Radioimmunoassay & ELISA Principles & Applications.	7
4.	<b>Electrophoresis &amp; PCR-</b> Principle, Types & Applications	8
5.	<b>Cardiac Profile</b> - In brief Hypertension, Angina, Myocardial Infarction, Pattern of Cardiac Enzymes in heart diseases	8
6.	<b>Different methods of Glucose and Cholesterol Estimation</b> Principal advantage and disadvantage of different methods	6
	<b>Total</b>	42

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Bailey and Scott's Diagnostic Microbiology, 13th ed Patricia M. Tille (2015)
2.	Clinical Biochemistry 5th edition, Allan Gaw & Michael J. Murphy & Rajeev Srivastava & Robert A. Cowan & Denis St. J. O'Reilly (2014)
3.	Fundamentals of Clinical Trials 4th edition, Springer Lawrence Friedman (2010)
4.	Molecular Biology of the Cell by B. Alberts et al. 6 <sup>th</sup> ed. Garland Science (2015)
5.	Medical Microbiology, 4th edition (1996)

**PLANT METABOLIC ENGINEERING**

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Plant Metabolic Engineering (BT417)</b>	3	0/1	2/0	Nil

**Course Objective:**

Plant metabolic engineering principles

**Course Outcome (CO):**

1.	Illustrate classification, synthesis and degradation of sucrose and starch and learn diurnal fluctuations in plants and their regulation.
2.	Summarize photosynthesis whole process including light absorption and energy conservation, pigment systems I and II and their structural organization, electron transport and ATP synthesis.
3.	Discuss synthesis and degradation of fats and fatty acids and $\alpha$ - and $\beta$ -oxidation.
4.	Construct pathways and networks and analyse the importance of secondary metabolites in medicine and agriculture.
5.	List the steps involved in pathway engineering for new products and new pathways and redirecting metabolic flow desensitization of feedback inhibition.

S.No.	Content	Contact Hours
1.	<b>Carbohydrate metabolism:</b> Classification, Synthesis and degradation of sucrose and starch. Diurnal fluctuations in plants and their regulation. Genetic engineering of sugars.	<b>8</b>
2.	<b>Photosynthesis:</b> Light absorption and energy conservation, pigment systems I and II and their structural organization, electron transport and ATP synthesis. Calvin's cycle, Transcription, translation and regulation of plastid genes in chloroplast development. Genetic engineering of photosynthesis.	<b>8</b>
3.	<b>Lipid metabolism:</b> Synthesis and degradation of fats and fatty acids. $\alpha$ - and $\beta$ -oxidation. Outlines of terpenoid and flavonoid pathways, signal transduction.	<b>9</b>
4.	<b>Concept of secondary metabolites.</b> Historical and current status. Importance of secondary metabolites in medicine and agriculture. Introduction to pathways and their networking. Transfer of entire pathways and completion of partial pathways through genetic engineering.	<b>9</b>
5.	<b>Metabolic engineering:</b> Pathway engineering for new products and new pathways, redirecting metabolic flow – desensitization of feedback inhibition, elevating rate limiting enzymes.	<b>8</b>
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Lincoln, Tiaz and Eduardo Zeiga Plant Physiology, Paxima Publishing Co. (2003)
2.	Buchanan, B.B. Gruissson, W. and Jones R.S. (2). Biochemistry and Molecular Biology of Plants, (2000)
3.	Derris D.T., Turpa, D.H. Leferbure, D.D. and Layzell D.B.. Plant Metabolism. (1987)

4.	Lodish, H. Berk A, Zipursty S.C., Matudaira, P. Baltimore, D and Darell J. Molecular Biology, W.H. Freeman and Company. (2000)
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## CROP PROTECTION AND PEST MANAGEMENT

### Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Crop protection and pest management (BT419)</b>	03	01	00	Nil

### Course Objective:

To provide a basic knowledge of pest control and yield enhancement.

### Course Outcome (CO):

1. Perceive the losses in crops due to pest and realize their importance. Classify plant diseases and understand their causes and symptoms.
2. Explain genetics of pathogenicity, Pathotypes and Mechanism of disease resistance.
3. Analyse of genetic engineering for improvement of disease resistance, Genetic manipulation of Crops for insect resistance, herbicide resistance and abiotic stress resistance.
4. Identify concepts and techniques for biological and chemical control like Bio-organism for pest management, Bt based pesticides, Baculovirus pesticides, Mycopesticides, production and formulation technologies.
5. Outline the principles of integrated Pest Management (IPM), IPM practices for important crops.

S.No.	Content	Contact Hours
1.	<b>Introduction to crop protection:</b> Losses in crops due to pests, Importance of plant diseases, Classification of plant diseases, Causes and symptoms of plant diseases, Disease epidemics, Prevention of epidemics	<b>8</b>
2.	<b>Pathogenicity,:</b> Genetics of pathogenicity, Pathotypes, Mechanism of disease resistance, breeding for disease and insect resistance	<b>8</b>

3.	<b>genetic engineering and stress resistance</b> Genetic engineering for improvement of disease resistance, Genetic manipulation of Crops for insect resistance, herbicide resistance, abiotic stress resistance	<b>9</b>
4.	<b>Chemical and Biological control</b> -concepts and techniques, Bio-organism for pest Management, Bt based pesticides, Baculovirus pesticides, Mycopesticides, production and formulation technologies	<b>9</b>
5.	<b>Integrated pest management:</b> Principles of integrated Pest Management (IPM), IPM practices for important crops	<b>8</b>
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
1	Brock T.D. and Modigaa M.T. (Latest edition) Biology of Microorganisms, Prentice Hall, New Jersey Pelczar M.J; Chan E.C.S. and Kreig N.R. 1993.
2	Microbiology, Tata Mc-Graw HTK Publishing Co., New Delhi. Stainer, R.Y; Ingram J; Wheelis, M.G. and Paintor, P.R. 1986
3	The Microbial World-Prentice Hall-New Jersey Alexander M. 1985,;
4	Introduction to soil Microbiology John Wileys & Sons, New York Rangaswamy. G and Bagyaraj, D.I. (1992)
5	Agricultural Microbiology, Asia Publishing House, New York. Subba Rao N.S. 1987 Advance in Agricultural Microbiology, Oxford & IBH.

**BIOSENSOR**

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Biosensor (BT421)</b>	03	01	00	Nil

**Course Objective:**

This course will present an overview of the fundamental principles, technologies, methods and applications of biosensors. The objective of this course is to link engineering principles to understanding biosystems in sensors and bioelectronic. Furthermore, the application of fundamentals of measurement science to optical, electrochemical, mass and pressure signal transduction

**Course Outcome (CO):**

1. Define biosensors and understand its history, properties, design features and the biological component.
2. Distinguish between different type of biosensors like amperometric and potentiometric biosensor and detecting of various cations using calorimetric biosensor.
3. Show overview of sensors and transducers measurement systems their Classification and Important design considerations.
4. List examples of biosensors with the relatable opportunities and obstacles. And learning about miniaturized devices in nanobiotechnology.
5. Discuss the Future of Biosensors and Transducers and the importance of computers in sensor and transducer technology.

S.No.	Content	Contact Hours
1.	<b>Introduction:</b> Biosensors: Definition, History, Properties of biosensors, Design features of biosensors, The biological component.	<b>6</b>
2.	<b>Signal Transduction:</b> Amperometric Biosensors, Potentiometric biosensors, Detection of H <sup>+</sup> cation, Detection of NH <sub>4</sub> <sup>+</sup> cation, Detection of CN <sup>-</sup> anion; Calorimetric biosensors, Optical biosensors, Measuring the change in light reflectance, Measuring luminescence, Piezo-electric biosensors, Immunosensors.	<b>12</b>
3.	<b>Biomedical Sensors:</b> Sensors and transducers: an overview, measurement systems, Classification of biomedical sensors and transducers, Why do we need Biomedical sensors and transducers? Important design considerations and system calibration.	<b>10</b>
4.	<b>Commercial Examples of Biosensors:</b> Biosensors markets: Opportunities and obstacles. <b>Miniaturized devices in nanobiotechnology</b> - types and applications, MEMS, Lab on a chip concept	<b>6</b>
5.	<b>The Future of Biosensors and Transducers:</b> Sensing Layer: The importance of computers in sensor and transducer technology, Recent engineering solutions to health care using biosensors and transducers, Modern health care solutions.	<b>8</b>
<b>TOTAL</b>		<b>42</b>

**Books:-**

S.No.	Name of Books/ Author/Publisher
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1.	Affinity Biosensors: Techniques and Protocols by K.R. Rogers and A. Mulchandani. Publisher: Humana Press.
2.	Biosensors and their Applications by V.C. Yang and T.T. Ngo. Publisher: Springer.
3.	Chemical Sensors and Biosensors by B.R. Eggins. Publisher: John Wiley and Sons Inc.
4.	Sensors and Sensing in Biology and Engineering by F.G. Barth, et al. Publisher: Springer Verlag.
5.	Bioinstrumentation and Biosensors by D.L. Wise. Publisher: Marcel Dekker.
6.	Process Biotechnology Fundamentals by S N Mukhopadhyay. Publisher: Viva Books Pvt. Ltd., New Delhi.

## GREEN ENERGY TECHNOLOGY

### Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Green Energy Technology (BT423)</b>	03	01	00	Nil

### Course Objective:

This paper exposes students to the renewable resources of energies and energy conversion processes. It teaches the uses of clean energy technologies and their importance in sustainable development

### Course Outcome (CO):

1. Classify energy sources; review conventional energy resources.
2. Discuss solar radiation and its measurements, prediction, and utilization of solar radiation in different aspects.
3. Identify biomass generation, utilization and Properties and learning techniques for biomass assessment, Bio-based chemicals, and materials.
4. Outline principles and conversion of wind, ocean, geothermal & waste energy into each other.
5. Define and distinguish between green chemistry and green nanotechnology.

S.No.	Content	Contact Hours
1.	<b>Energy Sources, Green Energy and Sustainable Development:</b> Introduction to nexus between Energy, Environment and Sustainable Development; Classification of energy sources; Review of conventional	8

	energy resources; Fossil fuel reserves; Renewable resources; Global environment concerns: Global warming, Ozone layer depletion, Greenhouse gas emissions; Clean/green energy technologies; International agreements/conventions on energy and sustainability	
2.	<b>Solar Energy Utilization:</b> Solar radiation: measurements and prediction; Earth and Sun relation; Solar thermal collectors; Thermal storage; Conversion of heat energy in to mechanical energy; Solar thermal power generation systems; Solar Photovoltaic; Types of solar cells; Solar photocatalysis; Solar energy based industrial processes and systems; Greenhouse technology	8
3.	<b>Biomass Energy Utilization, Bioenergy and Biomethanation:</b> Biomass generation and utilization; Properties of biomass; Agriculture crop and forestry residues used as fuels; Techniques for biomass assessment; Bio-based chemicals and materials; Biomass energy conversion processes; Biochemistry and process parameters of bio methanation; Importance of biogas technology; Biogas digester types; Aerobic and anaerobic bioconversion processes; Applications of biogas	8
4.	<b>Wind, Ocean, Geothermal &amp; Waste to Energy Conversion:</b> Wind energy potential measurements; Principles of wind energy conversion Wind energy conversion systems; Wind electric generator; Ocean energy resources; Principle of ocean thermal energy conversion systems; Ocean thermal power plants; Principles of ocean wave energy and tidal energy conversion; Types of geothermal energy deposits; Geothermal power plants; Introduction to waste and waste processing; Types and composition of various types of wastes; Waste to energy conversion processes	8
5.	<b>Green Management:</b> Introduction to green chemistry, green nanotechnology	10
	<b>Total</b>	42

Books: -

S.No.	Name of Books/ Author/Publisher
1.	Renewable Resources and Renewable Energy- A Global Challenge by M. Graziani and P. Fornasiero. 2 <sup>nd</sup> Ed. CRC-Taylor and Francis
2.	Fundamentals of Renewable Energy Processes by Aldo da Rosa, Academic Press
3.	Municipal Solid Waste to Energy Conversion Processes: Economic, technical and Renewable Comparisons by Gary C. Young. John Wiley & Sons
4.	Biogas from waste and renewable resources by Dieter D. and Angelika S. Wiley-VCH Publication
5.	Energy and the Environment by Ristinen, Robert A. Kraushaar, Jack J. A Kraushaar, Jack P. Ristinen, Robert A., 2nd Ed. John Wiley
6.	Solar Photovoltaics: Fundamental Applications and Technologies by C. S. Solanki. Prentice Hall of India

7.	Solar Cell Device Physics by Stephen Fonash. Academic Press
8.	Solar Energy Handbook, J F Kreider and Frank Kreith, McGraw Hill

### FOOD ENGINEERING & BIOTECHNOLOGY

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Food Engineering &amp; Biotechnology (BT425)</b>	3	1	0	

**Course Objective:**

To impart broad understanding of food technology, industrial food production and product regulations.

**Course Outcome (CO):**

1. To understand food biotechnology, scope of food biotechnology and its tools for trade.
2. To master recombinant proteins and their biological roles.
3. To elucidate the application of plant biotechnology in food.
4. To understand cell culture and Food (Brewing, dairy biotechnology, food additives), in Diagnostic Systems.
5. To apprehend biotechnological approach for the exploitation of food and industrially important microorganism, Bio Gas Plant.
6. Explain downstream processing Ethics and safety of
7. food biotechnology products Regulations of food biotechnology.

S.No.	Content	Contact Hours
1.	Scope of Food Biotechnology (What is the difference between food technology and food biotechnology?) Tools of the Trade (How biotechnology techniques relate to food?)	8
2.	Recombinant Proteins (Production and applications in food), Biological Role of DNA in cell metabolism, Cell and tissue culture, Secondary metabolites synthesis.	8

3.	Plant biotechnology in foods (Application to food production, food industries, pharmaceuticals, and agriculture)	6
4.	Cell Culture and Food (Brewing, dairy biotechnology, food additives), Diagnostic Systems (How and Why and application in food)	7
5.	Biotechnological Approach for the exploitation of food and industrially important microorganism, Bio Gas Plant	6
6.	Industrial Cell culture (Downstream processing Ethics and safety of food biotechnology products Regulations of food biotechnology)	7
<b>Total</b>		42

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Name of Books/ Author/Publisher
2.	Advances in Biotechnology Vol.1, (Scientific and Engineering principles). Murray Moo-Young, C.W. gambell and C.Vezina
3.	Advances in biotechnology Vol-II, (Fuels, chemical, food and waste treatment) Murray Moo-Young, C.W. gambell and C.Vezina
4.	Introduction to Plant Biotechnology, H. S. Chawla, 2004
5.	Fundamentals of Food Biotechnology By Byong H. Lee, wiley publications, 2015

**WASTE WATER TREATMENT**

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Waste Water Treatment (BT427)</b>	3	1	0	Nil

**Course Objective:**

To understand the basics of waste Water Treatment and apply these principles on real world case studies.

**Course Outcome (CO):**

1. Understand methods of industrial waste disposal and their effects on streams and sewerage systems.
2. Analyze the characteristics and toxic byproducts of wastes from various industries.
3. Explore methods for waste reduction, recycling, and economic sustainability in waste management.
4. Learn about unit operations and design for treating solid, liquid, and gaseous wastes.
5. Understand landfill design, operation, gas recovery, and site monitoring.
6. Apply waste management principles through real-world case studies.

S.No.	Content	Contact Hours
1.	Waste disposal management: Methods of waste disposal: industrial waste (solid, liquid and gaseous emission), effect of industrial wastes on streams and sewerage systems, Treatment system of waste disposal e.g. Incenerator, differences in waste quality and quantity, physico-chemical and biological treatments of waste and their evaluation in respect of treatment.	7
2.	Characteristic features of wastes (solid, liquid and gaseous emission), manufacturing processes and toxic byproducts generated from iron, ore, alumina, heavy metals units, paper and pulp industries, pesticides industry, thermal power station, distillery, textile and crude oil industry.	6
3.	Small- and large-scale industries for waste reduction and remediation, various methods for waste alteration, volume and strength minimization, recycling plants, material restoration and conservation. Methods for neutralisation, equalization, precipitation and solidification for waste handling. Economic sustainability and government support for joint treatment of raw effluent, municipal sewage and debris	7
4.	Unit operations and their design for treatment and management of wastes (solid, liquid and gaseous).	8
5.	Landfill design and operation including: site selection, engineered sites, liners and covers, leachate control and treatment, gas recovery and control, including utilization of recovered gas (energy), and landfill monitoring and reclamation.	8
6.	Case studies	6
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	S. P. Mahajan, "Pollution Control in Process Industries", Tata Mc Graw Hill Publications.
2.	W. Wesley Eckenfelder Jr., "Industrial Water Pollution Control", Mc Graw Hill Publications.
3.	Ronald W. Crites Sherwood C. Reed and Robert Bastion, "Land Treatment Systems for Municipal & Industrial Wastes" Mc Graw Hill Publications.
4.	Neal K. Ostler, "Industrial Waste Stream Generation", Prentice Hall
5.	Rao and Dutta, "Industrial waste treatment". Oxford and IBH Publishing Co. Pvt Ltd., New Delhi.

## BIOPROCESS PLANT DESIGNING

### Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Bioprocess plant designing (BT429)</b>	03	01	00	Nil

### Course Objective:

Subject deals with engineering principles for design of systems for processing biological materials into desired products.

### Course Outcome (CO):

1. Outline the key technologies used in bioprocess plant design.
2. Discuss construction material for a bioprocess plant and its mechanical design.
3. Compare designs of bioreactor to ensure its sterility of equipment using different case study.
4. Knowledge of mass transfer equipment designing and utilities in Biotechnology.
5. Explain Production plants; Process economics; Bioprocess validation; Safety considerations. Case studies.

S.No.	Content	Contact Hours
1.	Introduction, general design information; Mass and energy balance.	<b>6</b>
2.	Materials of construction for bioprocess plants; Mechanical design of process equipment; Vessels for biotechnology application.	<b>9</b>

3.	Design of fermenters; Design considerations for maintaining sterility of processing equipment; Piping and instrumentation; Penicillin case study.	9
4.	Selection and specification of equipment for handling fluids and solids; Design of heat and mass transfer equipment; Design of facilities for cleaning of process equipment; Utilities for biotechnology.	9
5.	Production plants; Process economics; Bioprocess validation; Safety considerations. Case studies.	9
Total		42

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Chemical Engineering by R.K. Sinnott, J.M. Coulson and J.F. Richardsons. Publisher: Butterworth-Heinemann. Vol-6, Butterworth Heinemann III edition
2.	Applied Process Design for Chemical and Petrochemical Plants by E.E. Ludwig. Publisher: Butterworth-Heinemann
3.	Chemical Engineers Handbook by RH. Perry and D.W. Green. Publisher McGraw-Hill 8th edition
4.	Process Biotechnology Fundamentals by S.N. Mukhopadhyay. Publisher: Viva Books
5.	Plant Design and Economics for Chemical Engineers by M. Peters and K. Timmerhaus. Publisher: McGraw-Hill

**BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS**

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Bioethics and intellectual property rights (BT431)</b>	03	01	00	Nil

**Course Objective:**

To discuss various aspects of biosafety regulations, IPR and bioethic concerns arising from the commercialization of biotech products.

**Course Outcome (CO):**

1. Outline the basics of Intellectual Property Rights, its history, evolution of IPR like patent, design and copyright, WIPO, WTO and property right.
2. Summarize patents and understand the process of applying, requirement, and classification.
3. Identify the need of biosafety and other regulatory framework for the safety of living organisms.
4. Discuss the relationship between IPR and biosafety Benefits of transgenics to human health, society, and the environment.
5. List ethical issues related to healthcare & medicine, food & agriculture, genetic engineering, and testing.

S.No.	Content	Contact Hours
1	<b>General Overview of Intellectual Property Rights:</b> History and evolution of IPR like patent, design and copyright, WIPO, WTO, Trade related Intellectual Property Right International background of intellectual property	9
2	<b>Patents:</b> Requirement of patentable novelty, inventive step, prior art Classifying products as patentable and non-patentable Procedure for applying for patent Patent Infringement and related case studies Biological Patentability	8
3	<b>Biosafety</b> and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.	9
4	<b>IPR and Biotechnology:</b> Biopiracy and Bioprospecting Farmers Rights and Plant breeders rights Biodiversity, Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-radio isotopic procedure; Benefits of transgenics to human health, society and the environment.	8
5	<b>Bioethics:</b> Bioethical issues related to Healthcare & medicine Food & agriculture Genetic engineering The Human Genome Project and Genetic Testing, Environmental problems	8
Total		42

**Books: -**

S.No.	Name of Books/ Author/Publisher
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1.	WTO-Trade-related Aspects of Intellectual Property Rights Edited by P.T. Stoll, J. Busche, K. Arend (2009).
2.	Intellectual Property Rights in Agricultural Biotechnology by F.H. Erbisch and K.M. Maredia (2000).

### **BIOMEDICAL INSTRUMENTATION, BIOSENSOR AND TRANSDUCER**

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Biomedical Instrumentation, Biosensor and Transducer (BT433)</b>	03	01	00	Nil

<b>Course Objective:</b> To understand the basic workflow and principle of biosensors and transducer
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<b>Course Outcome (CO):</b>	
1	Understand the basic principles, working mechanisms, and technical specifications of various physiotherapy, electrotherapy, and radiation therapy equipment, including safety aspects and clinical applications.
2	Comprehend the functioning, safety aspects, and clinical applications of surgical instruments such as surgical diathermy machines, cardiac pacemakers, defibrillators, and hemodialysis equipment
3	Explore the components, types, transducers, and applications of biosensors, including their use in clinical analysis, environmental monitoring, and modern scientific research.
4	Understand the functioning and models of various biological sensors/receptors in the human body, including their neural mechanisms and signal processing in time and frequency domains.
5	Analyze the principles, interface characteristics, and types of electrodes used in biochemical transducers, including applications in recording bio-signals like ECG, EEG, and EMG.
6	Investigate the principles, types, and applications of optical and pulse sensors, including photo detectors, optical fiber sensors, and photoelectric pulse transducers, in various biomedical applications.

S.No	Content	Contact Hours
1	Physiotherapy, Electrotherapy and Radiation Therapy Equipment's: Basic principle, working and technical specifications of Shortwave Diathermy, Ultrasonic therapy unit, Infrared and UV lamps, Nerve and Muscle Stimulator, Radiation and Physical therapy Units. Surgical Instruments: Surgical	<b>8</b>

	Diathermy machine, electrodes used with surgical diathermy, safety aspects in electronic surgical units, surgical diathermy analyzers, Cardiac pacemaker and defibrillator, hemodialysis.	
2	Introduction, what are Biosensors? Various components of biosensors, Types of Biosensors, Advantages and limitations Biocatalysis based biosensors, bio-affinity based biosensors & microorganisms-based biosensors, biologically active material and analytes, Types of membranes used in biosensor constructions. Transducers in Biosensors, Various types of transducers; principles and applications, Calorimetric, optical, potentiometric/amperometric conductometric/resistor metric, Transducers in Biosensors II Piezoelectric, semiconductor, impedimetric, mechanical and molecular electronics-based transducers. Chemiluminescence - based biosensors. Application and uses of Biosensors, Biosensors for personal diabetes management, Microfabricated Sensors and the Commercial Development of the I- Stat- Point-of-Care system. Non-invasive Biosensors in Clinical Analysis, Surface Plasmon Resonance, Biosensors based on Evanescent Waves, Applications of Biosensor-based instruments to the bioprocess industry, Application of Biosensors to environmental samples, Nanomaterials based biosensors, Introduction to Biochips and their application in modern sciences, Bimolecular electronics.	8
3	Study of biological sensors: Sensors / receptors in the human body, basic organization of nervous system-neural mechanism and circuit processing. Chemoreceptor: hot and cold receptors, baro receptors, sensors for smell, sound, vision, osmolality and taste. Sensor models in the time and frequency domains.	9
4	Biochemical Transducers: Electrode theory: electrode-tissue interface, metal-electrolyte interface, electrode-skin interface, electrode impedance, electrical conductivity of electrode jellies and creams. Biopotential electrodes: microelectrodes, body surface electrodes, needle electrodes. Reference electrodes: hydrogen electrodes, silver-silver chloride electrodes, Calomel electrodes. Recording electrodes for ECG, EEG, and EMG. Transducers for the measurement of ions and dissolved gases, pH electrode, specific ion electrodes.	9
5	Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immunosensors. Basic principles of MOSFET biosensors	8
6	Optical sensor- photo detectors, optical fiber sensors, and indicator mediated transducers, general principles of optical sensing, optical fiber temperature sensors. Pulse sensor: photoelectric pulse transducer, strain gauge pulse transducer.	
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
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1.	R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.
2.	S.C. Cobbold, "Transducers for Biomedical Instruments", Prentice Hall.
3.	Brown & Gann, "Engineering Principles in Physiology Vol. I", Academic Press.
4.	Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
5.	Rao & Guha, "Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.

## BIostatISTICS

### Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Biostatistics (BT435)</b>	3	1	0	

### Course Objective:

To gain proficiency in random variables, probability distributions, correlation, regression, sampling, hypothesis testing, and ANOVA for statistical analysis.

### Course Outcome (CO):

1. Understand random variables, distribution functions, and mathematical expectation.
2. Learn key probability distributions and their applications.
3. Analyze correlation and regression methods, including least squares and correlation coefficients.
4. Explore sampling plans, central limit theorem, and large sample testing.
5. Understand Chi-square, t-distribution, and F-distribution and their applications.
6. Learn the principles and applications of one-way, two-way, and three-way ANOVA.

S.No.	Content	Contact Hours
1.	Random variable and Expectation: Random variable and distribution function. Jointly distributed random variables. Mathematical	7

	expectation. Statistical parameters. Moment generating function. Chebyshev's inequality	
2	Probability Distributions: Binomial distributions. Multinomial distribution. Geometric distribution. Poisson distribution. Normal distribution. Normal distribution as limiting case of Binomial distribution. Exponential distribution.	6
3	Correlation and Regression: Method of least square and curve fitting. Correlation. Karl Pearson's coefficient of linear correlation. Probable error. Rank correlation and Spearman's coefficient. Regression.	7
4	Sampling distributions and Large sample estimation: Sampling plans. Statistics and sampling distributions. The central limit theorem. The sampling distribution of the sample mean. The sampling distribution of the sample proportion. Tests of significance. Large samples testing. Sampling of attributes.	8
5	Exact sampling distributions and small sample test: The Chi-square distribution. Student's t-distribution. Snedecor's F- distribution. Their Properties and applications.	8
6	ANOVA: One - way analysis of variance. Two - way analysis of variance. Three - way analysis of variance.	6
<b>Total</b>		42

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Pagano, M. and Gaureau, K. 'Principles of Biostatistics', 7th ed. Thomson Learning, 2007
2.	Ross, S.M. 'Probability and Statistics for Engineers and Scientists' 3rd ed. Academic Press. 2005
3.	Walpole, R.E., Myers, R.H., Myers, S.L., Ye, K. 'Probability and Statistics for Engineers and Scientists' Prentice Hall, Inc. 2002.
4.	Taneja, H.C. 'Statistical Method for Engineering and Sciences' IK International, 2009

**BIOPROCESS PLANT DESIGN**

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Bioprocess Plant Design(BT404)</b>	3	1	0	Nil

**Course Objective:**

Subject deals with engineering principles for design of systems for processing biological materials into desired products

**Course Outcome (CO):**

1. Outline the key technologies used in bioprocess plant design.
2. Discuss construction material for a bioprocess plant and its mechanical design.
3. Compare designs of bioreactor to ensure its sterility of equipment using different case study.
4. Knowledge of mass transfer equipment designing and utilities in Biotechnology.
5. Explain Production plants; Process economics; Bioprocess validation; Safety considerations. Case studies.

S.No.	Content	Contact Hours
1	<b>Process development:</b> Introduction to Design – nature of design – Technical feasibility survey, Mass and energy balance, process development – data acquisition – design data information of project - Organization of project – Project documentation – codes and standards.	7
2	<b>Design Development:</b> Equipment selection and specifications-materials of construction – flow sheeting - piping and instrumentation – process safety and loss prevention.	6
3	<b>General site consideration:</b> Introduction – plant location and site selection – site layout- plant layout utilities – environmental considerations– waste management – visual impact – government regulations and other legal restrictions, community factors and other factors affecting investment and production costs – human resources.	7
4	<b>Selection and specification:</b> Selection and specification of equipment for handling fluids and solids; Selection, specification, design of heat and mass transfer equipment used in bioprocess industries; Design of facilities for cleaning of process equipment used in biochemical industries; Utilities for biotechnology	8
5	<b>Design of fermenters:</b> Design of fermentation, Design considerations for maintaining sterility of processing equipment.	8
6	<b>Process economics:</b> Production plants; Bioprocess validation; Safety considerations	6
	Total	42

**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Chemical Engineering by R.K. Sinnott, J.M. Coulson and J.F. Richardsons. Publisher: Butterworth-Heinemann. Vol-6, Butterworth Heinemann III edition, 2002
2.	Applied Process Design for Chemical and Petrochemical Plants by E.E. Ludwig. Publisher: Butterworth-Heinemann, 2001
3.	Chemical Engineers Handbook by RH. Perry and D.W. Green. Publisher McGrawHill 8th edition, 2008
4.	Process Biotechnology Fundamentals by S.N. Mukhopadhyay. Publisher: Viva Books , 2010
5.	Plant Design and Economics for Chemical Engineers by M. Peters and K. Timmerhaus. Publisher: McGraw-Hill, 2002

**POPULATION GENETICS****Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Population genetics (BT406)</b>	03	01	00	Nil

**Course Objective:**

Introduction to population genetics and evolutionary analysis

**Course Outcome (CO):**

1. Discuss basic scope and promises of population genetics.
2. Identify the population structure using various methods like hardy Weinberg equilibrium and Darwinian selection.
3. Differentiate between population genomics and proteomics.
4. Analyze evolutionary process using quantitative methods.
5. Define unselecting, quantitative traits and developmental constraints.
6. Define the genetic variation in the given population.

S.No.	Content	Contact Hours
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1.	<b>Introduction:</b> Scope & Premises of Population Genetics, Genetic and Phenotypic Variation Random Mating, Loci and alleles, Mutations and Polymorphisms, Genotype and Allele Frequencies, Effect of Mutations on Fitness, Rate of Spontaneous Mutation	6
2.	<b>Population Structure:</b> The Hardy-Weinberg Principle, Testing for Hardy-Weinberg Equilibrium, Extensions of the Hardy-Weinberg Principle, Linkage and Linkage Disequilibrium, Genetic Drift, The Wright-Fisher Model of Random Genetic Drift, Effective Population Size, Gene Trees and Coalescence, Mutation, The Neutral Theory, Recombination, Migration, Inbreeding and Heterosis, Darwinian Selection, Selection in Haploid Organisms, Selection in Diploid Organisms Overdominance, More Complex Types of Selection Molecular Population Genetics, Molecular Polymorphisms, Patterns of Change in Nucleotide and Amino Acid Sequences, Polymorphism and Divergence, Molecular Phylogenetics, Transposable Elements, mtDNA, Y-DNA: Separating History from Gene Flow	8
3.	<b>Population Genomics and proteomics:</b> Genome-Wide Patterns of Polymorphism, Human Population Genetics, Human Polymorphism , Population Genetic Inferences from Human SNPs , Population Structure Inferred from Human Polymorphism, Mendelian Disease and Population Genetics, Genetic Basis for Variation in Risk of Complex Disease, Human Origins	8
4.	<b>Evolutionary Analysis:</b> Quantitative Genetics, Quantitative Genetics of Natural Populations, Quantitative Trait Loci (QTLs), Types of Quantitative Traits, Genes That Affect Quantitative Traits, the Number of Genes Affecting Quantitative Traits, Methods for Mapping QTLs	7
5.	<b>UniSelection:</b> Measures of Fitness & Constant Fitness Models, Nonrandom Mating: Identity by descent, Inbreeding; Selection on Quantitative Traits, Pleiotropy and Developmental Constraints, Interactions of selection with other evolutionary forces, The Shifting Balance Theory, The Unit of Selection, Meiotic and Molecular Drive, Sexual, Frequency & Density Dependent Selection.	6
6.	<b>Genetic Variability in Natural Populations:</b> Introduction, Measures of Genetic Variation, Gene Diversity within Populations- Enzyme and Protein Loci, Blood Groups and other loci; Genetic Diversity in Subdivided Populations, Mechanisms of Maintenance of Protein Polymorphisms: Overdominance hypothesis, Other types of Balancing Selection, Neutral Mutations, Transient Polymorphisms due to selection.	7
<b>Total</b>		42

**Books: -**

S.No.	Name of Books/ Author/Publisher
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1.	Evolutionary Analysis, Scott Freeman, John C. Hendon, Fourth Edition Pearson Education.
2.	Molecular Genetic Analysis of Populations, Hoelzel, 2nd Edition, Oxford University,
3.	Genetics -Principles and Analysis Hartl and Jones, 5th edition Jones and Barlet.,
4.	Genetics of Populations P W Hedrick, 2nd Edition, Jones & Bartlett
5.	Principles of Population Genetics Hartl & Clark, Third Edition, Sinauer Associates Inc.

## BIOPOLYMERS

### Details of course :-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Biopolymers (BT408)</b>	03	01	00	Nil

### Course Objective:

The objective of this course is to provide students with a fundamental understanding of biopolymers, including their synthesis, properties, and applications. Students will learn about the environmental impact and biodegradability of biopolymers, develop practical skills through hands-on experiments, and explore the latest advancements in the field. The course aims to integrate knowledge from various scientific disciplines to solve complex problems and foster critical thinking and research skills in the study of biopolymers.

### Course Outcome (CO):

- 1 Develop the understanding of the basics of the biopolymers, bioplastics like starch based, cellulose based
- 2 Identify the classes of biodegradable polymer which can be natural, synthetic, and modified naturally
- 3 Identify mechanisms of improvement of properties by incorporating different elements
- 4 Compare bioplastics and bio composites, processing of bioplastics and biocompositers
- 5 List the uses of biomaterials for manufacture of plastic films, various types of films and application.

S.No.	Content	Contact Hours
1.	<b>Introduction:</b> Definition of Biopolymers and types of biopolymers, definition of bioplastics, Types of bioplastics, such as starch based, cellulose based plastics and some aliphatic polyesters (PLA, PHB), polyamides, Bio-Based Composites from Soybean Oil and Chicken Feathers, bio-derived	<b>8</b>

	polyethylene and genetically modified bioplastics. Environmental impact such as Bioplastics and biodegradation.	
2.	<b>Biodegradable polymer</b> classes, Natural biodegradable polymer, Synthetic biodegradable polymer and modified naturally biodegradable polymer. Non-biological and biological degradable polymer. Measuring of biodegradation of polymers- Enzyme assays, Plate test, Respiratory test, Natural environment, Field trial, Gas evolution test (CO <sub>2</sub> & CH <sub>4</sub> )	<b>8</b>
3.	<b>Composite implant materials:</b> Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with estrogenic fillers (e.g. hydroxyapatite). Host tissue reactions.	<b>9</b>
4.	<b>Bioplastics and Bio composites processing and their applications:</b> Introduction of bioplastics and biocomposites, processing of bioplastics and biocomposites, applications of bioplastics and their composites- civil engineering, biomedical, automotives applications	<b>9</b>
5.	<b>Applications and manufacture of Bio Plastics</b> Use of Biomaterials for manufacture of plastic films, various types of films and applications; usage of biological friendly plastics in homes, industry, etc. with specific applications. Mixing of biomaterials with plastics: equipment details, process details etc.	<b>8</b>
<b>Total</b>		<b>42</b>

**Books:-**

S.No.	Name of Books/ Author/Publisher
1	Handbook of Biopolymers and Biodegradable Plastics, 1st Edition Properties, Processing and Application
2	Natural Polymers, Biopolymers, Biomaterials, and Their Composites, Blends, and IPNs, Sabu Thomas, Neethu Ninan, Sneha Mohan, Elizabeth Francis
3	Biopolymers: Biomedical and Environmental Applications By Susheel Kalia, Luc Avérous wiley

**GENOMICS IN MEDICINE**

**Details of course :-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Genomics in medicine (BT410)</b>	03	01	00	Nil

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**Course Objective:**

This course aims to provide a foundational understanding of genomics and its applications in modern medicine. Students will learn to analyze genomic data, understand the genetic basis of diseases, and explore the role of genomics in personalized medicine. Additionally, the course will address the ethical, legal, and social implications of genomic research and its clinical applications, preparing students for future advancements and interdisciplinary collaboration in the field.

**Course Outcome (CO):**

- 1 Discuss involvement of biotechnology and genomics in medicine like gene medicine, disease models and their impact.
- 2 Compare between functional and comparative genomics, learning other genomics including mutational genomics.
- 3 Identify causative microbes , molecular epidemiology, host resistance to infection
- 4 List applications of genomics in genetic diseases like detection and treatment of single gene disorder.
- 5 Explain molecular basis of cancer, genomics impact and methods in cancer therapy
- 6 Perform case studies of cardiovascular and single gene disorder, therapies and application.

S.No.	Content	Contact Hours
1.	Biotechnology and Genomics in Medicine: Gene Medicine, Disease Models, Impact of Genomics on Medicine, Molecular Medicines	7
2.	Genomics: Human Genome Project Breakthroughs, Functional Genomics: Comparative Genomics, Transcriptomics, Proteomics, Mutational Genomics	6
3.	Genomics Applications in Infectious Diseases: Identification of causative microbes, molecular epidemiology, host resistance to infection, pathogenicity, combating infectious diseases	7
4.	Genomics Applications in Genetic Diseases: Genetic Disorders, detection and treatment of single gene disorders, analysis of polygenic disorders: linkage analysis, Linkage disequilibrium mapping, haplotypes, MHC, pharmacogenomics	8
5.	Genomics Applications in Cancer: Molecular basis of cancer, impact of genomics on cancer research, methods for the diagnosis of cancer, approaches to cancer therapy	8
6.	Case Study: Cardiovascular Disorders: Cardiovascular Single Gene Disorders, Cardiovascular Polygenic Disorders, Therapies and Applications	6

<b>Total</b>	<b>42</b>
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**Books: -**

S.No.	Name of Books/ Author/Publisher
1.	Human Molecular Genetics, Third Edition T. Strachan and A.P. Read, Garland Science Publication.
2.	Molecular Cell Biology, Sixth Edition (2007) H. Lodish, A. Berk, and C.A. Kaiser, W. H. Freeman & Co Ltd.
3.	Cardiovascular Genetics and Genomics for the Cardiologist Victor J. Dzau and Choong-Chin Liew, Blackwell Publishing.
4.	Genomics: The Science of Technology Behind the Human Genome Project Charles R. Cantor and Cassandra L. Smith, John Wiley & Sons, Inc.
5.	A Century of Mendelism in Human Genetics Milo Keynes, A.W.F. Edwards and Robert Peel, CRC Press.

### NANOBIOTECHNOLOGY

**Details of course:-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Nanobiotechnology (BT412)	03	01	00	Nil

**Course Objective:** The objective of this course is to impart interdisciplinary education in nanoscience and nanobiotechnology. The aim of this advanced course is to provide understanding for various nanobiotechnological application.

**Course Outcomes:**

1. Understand the basics concepts of nanosciences and its applications.
2. Applications of different types of nanomaterials and its compositions.
3. To gain knowledge about sensing technology.
4. To understand the basics of bio-photonics and bioimaging
5. Understanding the toxicological effects of nanomaterials and its management.

S.No	Content	Contact hours
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1	<b>Introduction:</b> Introduction to nanotechnology and overview of nanoscale materials, effect of length scale on properties, introduction to bionanotechnology, challenges and opportunities associated with biology on the nanoscale, biological and medical applications of bionanomaterials.	6
2	<b>Nanomaterials:</b> Introduction to nanomaterials, Unique functional properties of natural and synthetic biomolecular-sized (nanometer-scale) constructs such as quantum dots, carbon nanotubes, nanostructured surfaces, liposomes, Environmental behavior of nanoparticles, biological activity of nanomaterials.	10
3	<b>Biosensors:</b> Introduction to biosensors, the biological component, the sensor surface, Immobilization of the sensor molecule, Applications of molecular recognition elements in nanosensing of different analytes, Application of various transducing elements as part of nanobiosensors	6
4	<b>Biophotonics and Bioimaging:</b> Overview of imaging biological systems, from the cellular level through to whole-body medical imaging, Fluorescence spectroscopy  <b>Miniaturized devices in nanobiotechnology</b> - types and applications, MEMS, Lab on a chip concept	12
5	<b>Nanotoxicology:</b> Principles of toxicology; toxicology models, experimental toxicology studies; activation and detoxification mechanisms.  <b>Applications, Risks and Precautions:</b> In vivo diagnosis, in vitro diagnosis, therapy, cosmetics; Environmental and Risk Prevention; Risks and Ethical considerations.	8
	<b>Total</b>	<b>42</b>

**Books:**

S.No	Name of Book/Author/Publisher
1	Nanobiotechnology: Concepts, Applications and Perspectives, Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2	Nanobiotechnology - II more concepts and applications, Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
3	Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.
4	D.S. Goodsell, Bionanotechnology: Lessons from Nature, Wiley Press
5	G. Ozin, A. Arsenault, Nanochemistry. A Chemical Approach to Nanomaterials, RSC, London

**MEDICAL  
PHYSICS**

**Details of  
course :-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Medical physics (BT414)</b>	03	01	00	Nil

**Course Objective:**

To impart knowledge on application of physics is in explaining various physiological phenomena and its significance in biological systems. Also, this course imparts detailed aspects of biochemistry and its applications.

**Course Outcome (CO):**

- 1 Describe the functions of various cellular constituents like action potential and its measurements, functioning of skeletal muscles
- 2 Summarize the physics of the lungs and breathing by blood and lungs interactions, measuring the volumes, pressure of lungs and alveoli
- 3 List the major components of the cardiovascular system with oxygen and carbon di-oxide exchange in the Capillary System and applying Bernoulli's Principle to Cardiovascular system
- 4 Gain introduction to Bio molecules with their structure and properties of mono, di oligo and polysaccharides also Classifying lipids and learning their physical and chemical properties of fats and oils, phospholipids, fatty acids, prostaglandin
- 5 Discuss on structure and properties of amino acids, proteins, nucleic acids, vitamins and minerals

S.No.	Content	Contact Hours
1	<b>Functions of various cellular constituents:</b> Action potential and its measurements – Hodgkin–Huxley model, Functioning of skeletal muscles, Blood and lymph circulation,	<b>6</b>
2	<b>Physics of the Lungs and Breathing:</b> The airways- Blood and Lung interaction, Measurement of Lung Volumes, Pressure, Physics of the Alveoli, Breathing mechanism, Airway resistance	<b>8</b>
3	<b>Physics of the Cardiovascular system and Cardiovascular instrumentation:</b> Major Components of the Cardiovascular System, Oxygen and Carbon di-oxide exchange in the Capillary System, Bernoulli's Principle applied to Cardiovascular system, Laminar and Turbulent Blood Flow	<b>8</b>
4	<b>Bio – Chemistry (I):</b> Bio molecules – Carbohydrate - Structure and properties of mono, di oligo and polysaccharides, Classification of lipids - physical and chemical properties of fats and oils, phospholipids, fatty acids, prostaglandin	<b>10</b>
5	<b>Bio – Chemistry (II):</b> Structure and properties of amino acids, proteins, nucleic acids, vitamins and minerals	<b>10</b>
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
1	Voet D. and Voet G., "Biochemistry", Third Edn. John Wiley and Sons,
2	Medical Physics by J.R.Cameron and J.G.Skofronide ().
3	Lehninger Principles of Biochemistry by David . L. Nelson, Micheal . M. Cox, Fourth Edition, Macmillan Worth publishers.

**PHARMACEUTICAL SCIENCES****Details of course :-**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Pharmaceutical sciences (BT416)	03	01	00	Nil

**Course Objective:**

This course aims to provide students with a comprehensive understanding of drug discovery, development, and regulation. It covers the principles of pharmacology, medicinal chemistry, and pharmacokinetics, emphasizing the design, analysis, and clinical application of pharmaceuticals. Students will gain knowledge in drug formulation, delivery systems, and the role of biotechnology in modern medicine, preparing them for careers in research, development, and regulatory affairs in the pharmaceutical industry.

**Course Outcome (CO):**

- 1 Infer the classification and nomenclature of organic pharmaceutical compounds and their different types of effects like steric, inductive and mesomeric effect
- 2 Compare physiochemical properties of drugs in relation to biological, its effect an drug receptor interaction
- 3 Know the basics of drug metabolism and its various topics like Oxidative Reductive, Hydrolytic and Conjugative
- 4 Define toxicity, tolerance, dependence, addiction, interaction and reaction of drug with various factors like diseases and food
- 5 Perfrom survey of various drug classes like Anesthetics, Analgesics, Neurotransmitters CNS depressants, CNS stimulants, Antibiotics and Steroids.

S.No.	Content	Contact Hours
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1.	<b>Introduction to and History of Pharmaceutical Chemistry:</b> Classification and nomenclature of organic pharmaceutical compounds; Hyperconjugation, steric effects inductive effect and mesomeric effect.	<b>8</b>
2.	<b>Physicochemical Properties in Relation to Biological Action:</b> Effects of route of administration, Drug-receptor interactions, Steric features of drugs, The drug receptor, Structure-Activity Relationships	<b>8</b>
3.	<b>Drug Metabolism:</b> Oxidative Reductive, Hydrolytic, Conjugative	<b>9</b>
4.	<b>Drug Toxicity, Tolerance, Dependence, Addiction:</b> adverse drug reactions; Drug overdose; Drug-induced liver injury, Drug-drug interactions, Drug-disease interactions, Drug-food interactions; Intolerance to multiple drugs; Physical dependence, Psychological dependence, Cross dependence; Drug receptors; Learning, conditioning, and relapse.	<b>9</b>
5.	<b>Survey of Various Drug Classes:</b> Anesthetics (general, local), Analgesics, Neurotransmitters (adrenergic, cholinergic effects; psychopharmacology), CNS depressants (sedative/hypnotic, major/minor tranquilizers), CNS stimulants, Antibiotics (especially b-lactam), Steroids. Natural Products as Medicinal Compounds	<b>8</b>
<b>Total</b>		<b>42</b>

**Books: -**

<b>S.No.</b>	<b>Name of Books/ Author/Publisher</b>
1	Medicinal Chemistry: An introduction by G. Thomas. Publisher: John Wiley and Sons Medicinal Chemistry: The Role of Organic Chemistry in Drug
2	Research by C. R. Ganellin and S. M. Roberts. Publisher: Academic Press
3	Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems by H.C. Ansel, L. V Allien, N.G. Popovich. Publisher: Lippincott Williams and Wilkins Publishers.
4	Review of Organic Functional Groups: Introduction to Medicinal Organic Chemistry by TL. Lemke. Publisher: Lippincott Williams & Wilkins, 4 <sup>th</sup> edition

## AGRICULTURE MICROBIOLOGY

### Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Agriculture microbiology (BT418)</b>	03	01	00	Nil

### Course Objective:

Agriculture microbiology provides in depth knowledge about complex interaction between agriculture system and micro-organisms and introduce micro-organism in agricultural system for building a pathway for sustainable agriculture.

### Course Outcome (CO):

- 1 Understand the History and basics of Microbiology.
- 2 To comprehend the mechanism of ATP generation in bacteria during respiration.
- 3 To gain knowledge about different microbes and their roles.
- 4 Understand microbiology of food spoilage and food preservation.
- 5 Apply the benefits of microorganisms in agriculture.

S.No.	Content	Contact Hours
1.	<b>Introduction History of Microbiology</b> Spontaneous generation theory, Role of microbes in fermentation, Germ theory of disease, Plant Protection against infections.	<b>9</b>
2.	<b>Metabolism</b> Metabolism in bacteria: ATP generation, respiration, fermentation. Bacteriophages: structure and properties of Bacterial viruses–Lytic and Lysogenic cycles.	<b>9</b>
3.	<b>Microbial diversity</b> Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur, Microflora of Rhizosphere and Phyllosphere,	<b>9</b>
4.	<b>Food microbiology</b> Microbiology of food microbial spoilage and principles of food preservation.	<b>8</b>

5.	<b>Microrganisms in agriculture</b> Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Biodegradable plastics, Plant– Microbe interactions.	<b>10</b>
<b>Total</b>		<b>45</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
1	Industrial Microbiology: An Introduction by Michael J. Waites, Wiley-Blackwell (2009)
2	General microbiology by R.Y. Stanier, J.L. Ingraham, M.L. Wheelis and P.R. Painter. Publisher: Macmillan (1987)
3	Microbiology by Prescott Harley and Kliein. Publisher: Mc Graw Hill (2007)
4	Microbiology by M.J. Pelczar, E.C.S. Chan and N.R. Kreig. Publisher: Tata McGraw Hill (2005)

## NUTRACEUTICALS

**Details of course: -**

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Nutraceuticals (BT420)</b>	03	01	00	Nil

**Course Objective:**

This course will describe biochemistry, health benefits, development and regulation of nutraceuticals. It covers the scientific basis of nutraceuticals, their bioactive compounds, mechanisms of action, regulatory aspects, and their application in managing chronic diseases. The course also emphasizes the development, evaluation, and market potential of nutraceutical products.

**Course Outcome (CO):**

- 1 Define nutraceuticals and outline basis, properties, structure and functions. Classify them into different groups
- 2 Analyse nutraceuticals in diseases management especially for cancer, diabetes, cardiovascular and cholesterol management

3	Discuss development and manufacturing of nutraceuticals and also identifying analytical techniques in it
4	Outline interactions of prescription drugs and nutraceuticals and analyse adverse effects and toxicity of nutraceuticals
5	Explain nutrigenomics and its relation to nutraceutical, Scope of genetic engineering in nutraceutical production

S.No.	Content	Contact Hours
1.	<b>Introduction:</b> Definitions; Synonymous terms; Basis of claims for a compound as a nutraceutical; Properties, structure and functions of various nutraceuticals; Classification of nutraceuticals; Nutraceuticals of plant and animal origin; Microbial and algal nutraceuticals; Non-nutrient effects of specific nutrients; Antinutritional factors present in foods; Regulatory issues for nutraceuticals including CODEX	<b>8</b>
2.	<b>Nutraceuticals and Disease Management:</b> Concept of angiogenesis; Nutraceuticals for cardiovascular diseases, cancer, diabetes, cholesterol management, obesity, joint pain, immune enhancement, age-related macular degeneration	<b>8</b>
3.	<b>Nutraceutical Development:</b> Manufacturing of nutraceuticals (lycopene, isoflavonoids, prebiotics, probiotics, glucosamine, phytosterols); Formulation of functional foods containing nutraceuticals; Packaging and safety evaluation; Analytical techniques in nutraceutical industry	<b>8</b>
4.	<b>Clinical Testing of Nutraceuticals:</b> Interactions of prescription drugs and nutraceuticals; Adverse effects and toxicity of nutraceuticals	<b>8</b>
5.	<b>Nutrigenomics:</b> An introduction to nutrigenomics and its relation to nutraceuticals; Scope of genetic engineering in nutraceutical production; Production technology for recombinant therapeutic products using <i>E. coli</i> with examples like human insulin, growth hormones, interferons, erythropoietin; Biotechnology in phytonutraceuticals	<b>10</b>
<b>Total</b>		<b>42</b>

**Books: -**

S.No.	Name of Books/ Author/Publisher
1	Handbook of Nutraceuticals and Functional Foods by Robert E.C. 3 <sup>rd</sup> Ed. CRC Press
2	Dietary supplements and functional foods by Geoffrey P. Webb. 2 <sup>nd</sup> Ed. Wiley Blackwell Publishing
3	Anti-angiogenic functional and medicinal foods by Losso, JN. CRC Press

4	Dietary supplements: Toxicology and Clinical Pharmacology by Cupp, J., Tracy, TS. Humana Press.
5	Functional Food Ingredients and Nutraceuticals: Processing Technologies by Shi, J. CRC Press
6.	Nutritional Genomics: Impact on Health and Disease by Brigelius-Flohé, J., Joost, HG. Wiley-VCH
7.	Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals by Neeser, JR., German, BJ. Marcel Dekker
8.	Nutritional Genomics: The Impact of Dietary Regulation of Gene Function on Human Disease by Wayne R. Bidlack, Raymond L. Rodriguez. CRC Press

## TISSUE ENGINEERING AND ARTIFICIAL ORGANS

### Details of course :-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
<b>Tissue engineering and artificial organs (BT422)</b>	03	01	00	Nil

### Course Objective:

The goal of tissue engineering and artificial organs is to understand tissue and its interface with biomaterials and assemble functional constructs that restore, maintain, or improve damaged tissues or whole organs.

### Course Outcome (CO):

1. To illustrate the basic biological concepts
2. To describe the application of biomaterials to construct scaffolds for development of artificial organs.
3. To demonstrate the design and development of artificial organs
4. To introduce the types functionality and validation of artificial organs.
5. Understanding the case studies.

S.No.	Content	Contact Hours
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1	Historical perspective and introduction: Historical perspective of tissue engineering industry and products; Cell and Tissue Biology: Introduction to basic biology concepts; Stem cells and its applications.	8
2	Scaffolds for tissue engineering: Classification of scaffold materials, criteria for ideal scaffold, control of architecture; Design and Clinical Implementation	10
3	Design of artificial organs: Substitutive medicine, Biomaterial Concentration, Outlook for Organ Replacement, Design Consideration, Evaluation of Artificial Organs. Artificial Heart and Circulatory Assist Devices	10
4	Artificial organ studies: Artificial lungs; Artificial kidney; Artificial pancreas; Artificial blood; Artificial liver	8
5	Case studies: Comparison of Artificial Lungs and Natural Lungs, Insulin therapy	6
Total		42

**Books:-**

S.No.	Name of Books/ Author/Publisher
1	Biomaterials, artificial organs and Tissue engineering, Larry L. Hench, Julian R Jones, Wood head Publishing Ltd, 2005.
2	Principle of Tissue Engineering, Robert P.Lanza, Robert Langer William L.Chick. Academic Press, 2004.
3	Tissue Engineering, by Palsson and Bhatia (eds.), Pearson Prentice Hall, 2004.
4	Tissue Engineering and Artificial Organs by Joseph D.Bronzino Cardiogenic Shock by Steven M. Hollenberg.
5	Biomaterials, Artificial Organs and Tissue Engineering by Larry L.Hench and Julian R.Jones.

