DELHI TECHNOLOGICAL UNIVERSITY
Department of Biotechnology

M.Tech.
Industrial Biotechnology (IBT)

SCHEME & SYLLABUS (as per CBCS and NEP 2020)

With effect from : Academic Year-2024-25

DEPARTMENT OF BIOTECHNOLOGY

M. Tech. INDUSTRIAL BIOTECHNOLOGY

SEMESTER I										
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
	Core Courses									
IBT501	Bioenergy	DCC-1	4	3-0-2		15	25	20	40	-
IBT503	Industrial Plant Biotechnology	DCC-2	4	3-0-2		15	25	20	40	-
IBT505	Enzyme technology & Industrial Application	DCC-3	4	3-0-2		15	25	20	40	-
IBT507	Functional Genomics & Proteomics	DCC-4	4	3-0-2		15	25	20	40	-
	Departmental Elective - I				**24**					
IBT511	Industrial waste water treatment	DEC-1	4	3-1-0		25	-	25	50	-
IBT513	Bioinformatics			3-0-2		15	25	20	40	-
IBT515	Cell and Molecular Biology			3-0-2		15	25	20	40	-
IBT517	Recombinant DNA Technology			3-1-0		25	-	25	50	-
IBT519	Neurobiology			3-1-0		25	-	25	50	-
	Skill Enhancement Course - 1									
IBT541	Cell Culture Technology	SEC-1	2	0-0-4		-	50	-	-	50
IBT543	Biotechnology Entrepreneurship & Venture Development			2-0-0		25	-	25	50	-
	Self-Study Course									
IBT551	Seminar	SSC	2	2-0-0		25	-	25	50	-
IBT553	MOOC									
	Audit Course									
UEC501	English for Research Paper Writing	AUC	Non-Credit	2-0-0		25	-	25	50	-
UEC503	Disaster Management			2-0-0		25	-	25	50	-
UEC505	Sanskrit for Technical Knowledge			2-0-0		25	-	25	50	-
UEC507	Value Education			2-0-0		25	-	25	50	-
UEC509	Constitution of India			2-0-0		25	-	25	50	-

UEC511	Pedagogy Studies			2-0-0		25	-	25	50	-
UEC513	Stress Management by Yoga			1-0-2		15	25	20	40	-
UEC515	Personality Development through Life Enlightening Skills			2-0-0		25	-	25	50	-
UEC517	Indian Music			1-0-2		15	25	20	40	-
UEC519	Sports and Rehabilitation			1-0-2		15	25	20	40	-
UEC521	Multi-Dimensional Poverty Indices for Developing Countries			1-0-2		15	25	20	40	-
SEMESTER II										
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
	Core Courses									
IBT502	Advanced Environmental Biotechnology	DCC-5	4	3-0-2		15	25	20	40	-
IBT504	Biosafety, Bioethics & IPR	DCC-6	4	3-1-0		25	-	25	50	-
	Departmental Elective - 2									
IBT520	Industrial Microbiology and Fermentation Technology	DEC-2	4	3-1-0		25	-	25	50	-
IBT522	Food Engineering & Biotechnology			3-1-0		25	-	25	50	-
IBT524	Biopolymer Technology			3-1-0		25	-	25	50	-
IBT526	Plant Molecular Pharming			3-1-0		25	-	25	50	-
IBT528	Nano biotechnology			3-1-0		25	-	25	50	-
	Departmental Elective - 3				**24**					
IBT530	Biosensor Technology	DEC-3	4	3-1-0		25	-	25	50	-
IBT532	Bioinstrumentation			3-1-0		25	-	25	50	-
IBT534	Immunology and Vaccine Technology			3-1-0		25	-	25	50	-
IBT536	Metabolic Engineering			3-1-0		25	-	25	50	-
IBT538	Transgenic Technology			3-1-0		25	-	25	50	-
	Skill Enhancement Course - 2 /Industrial Training									
IBT540	Industrial Training	SEC-2	4	2-0-4		15	25	20	40	-
IBT542	Aquaculture			3-1-0		25	-	25	50	-
IBT544	AI in Health care			3-1-0		25	-	25	50	-

UCC502	Research Methodology and IPR	UCC	4	3-1-0		25	-	25	50	-
SEMESTER III										
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
	Core Course									
IBT601	Bioprocess Engineering & Reactor designing	DCC-7	4	3-0-2		15	25	20	40	-
	Open Elective				**16**					
OBT601	Human Nutrition	OEC	4	3-1-0		25	-	25	50	-
IBT603	Minor Project/Research Thesis/Patent	DCC-8	8	-		**-**	**40**	**-**	**-**	**60**
SEMESTER IV										
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
IBT604	Major Project/Research Thesis/Patent	DCC-9	16	-	**16**	**-**	**-**	**-**	**-**	**100**

List of AICTE approved Audit Course

Code	Audit Course Name
UEC501	English for Research Paper Writing (L: 2, T: 0, P: 0)
UEC503	Disaster Management (L: 2, T: 0, P: 0)
UEC505	Sanskrit for Technical Knowledge (L: 2, T: 0, P: 0)
UEC507	Value Education (L: 2, T: 0, P: 0)
UEC509	Constitution of India (L: 2, T: 0, P: 0)
UEC511	Pedagogy Studies (L: 2, T: 0, P: 0)
UEC513	Stress Management by Yoga (L: 1, T: 0, P: 2)
UEC515	Personality Development through Life Enlightening Skills (L: 2, T: 0, P: 0)

Program Outcomes

1. **Scholarship of Knowledge:** Acquire in-depth knowledge of a specific discipline or professional area, including a more comprehensive and global perspective, with an ability to discriminate, evaluate, analyze, and synthesize existing and new knowledge and integrate the same to enhance understanding.
2. **Critical Thinking:** Critically analyze complex engineering problems and apply independent judgment when synthesizing information to make intellectual and creative advances in conducting research in a broader theoretical, practical, and policy context.
3. **Problem-Solving:** Think laterally and initially, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems, and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal, and environmental factors in the core areas of expertise.
4. **Research Skill:** Extract information pertinent to unfamiliar problems through literature surveys and experiments; apply appropriate research methodologies, techniques, and tools; design and conduct experiments; analyze and interpret data; demonstrate higher-order skill and view things in a broader perspective; contribute individually or in group(s) to the development of scientific, technological knowledge in one or more domains of engineering.
5. **Usage of modern tools:** Create, select, learn, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
6. **Collaborative and Multidisciplinary work:** Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, and make decisions based on open-mindedness, objectivity, and rational analysis to achieve common goals and further their own and others' learning.
7. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply them to work as a team member and leader. Manage projects efficiently in respective disciplines and multidisciplinary environments after considering economic and financial factors.
8. **Communication:** Communicate confidently and effectively with the engineering community and society regarding complex engineering activities, such as comprehending and writing effective reports and design documentation by adhering to appropriate standards, making effective presentations, and giving and receiving clear instructions.
9. **Lifelong Learning:** Recognize the need for and have the preparation and ability to engage in lifelong learning independently, with enthusiasm and commitment to continuously improving knowledge and competence.
10. **Ethical Practices and Social Responsibility:** Acquire professional and intellectual integrity, a professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices, and an understanding of the responsibility to contribute to the community for the sustainable development of society.
11. **Independent and Reflective Learning:** Observe and critically examine the outcomes of one’s actions, make corrective measures, and learn from mistakes without depending on external feedback.

M.Tech in (IBT) syllabus

FIRST YEAR (Semester 1)

BIOENERGY (IBT501)

Details of course : -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Bioenergy	3	0	2	Nil

Course Objective: To gain understanding on the concepts of bioenergy, global energy scenario, and production of Bio hydrogen and biodiesel

Course Outcomes:	
CO1	To gain understanding on the Global Energy Scenario, and Biofuel Production
CO2	To understand the concepts of Bio-ethanol Production
CO3	To impart knowledge on the production of Bio hydrogen by Agricultural residues
CO4	To gain understanding on the concepts of Biodiesel Production
CO5	To understand the concepts of applied Bioenergy with reference to Indian context

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	2	2	3
CO2	**3**	**2**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

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S. No.	Content	Contact Hours
Unit 1	**Introduction:** Global energy scenario, Indian energy scenario, types of energy sources, description of various biofuels, Bioenergy from Biomass. Biofuel production.	**8**
Unit 2	**Production of Bio-ethanol**: Process Technology for Bioethanol production using Sugar, Starch and Lignocellulosic. Selection of micro- organisms and raw materials; Unit Operations in Alcohol production, Alcohol distillation.	**9**
Unit 3	**Production of Biodiesel**: Lipids as a source of biodiesel; Methods of Biodiesel Production – General procedure and large scale production; Quality Control Aspects. Biodiesel production from microalgae and Future prospects.	**9**
Unit 4	**Production of Biohydrogen**: Biohydrogen production by anaerobic bacteria and photosynthetic algae, Enzymes involved in Biohydrogen production. Biochemical Pathway, Factors affecting Biohydrogen Production.	**10**
Unit 5	**Applied Bioenergy**: Concept of Applied Bioenergy and its advancements with other sources of energy, Recent trends in bioenergy research. Relationship of Applied Bioenergy to Economy, Sustainable Development and Environmental Policies.	**9**
	Total	**45**

Lab- Bioenergy

- Measurement of current from battery devices.
- Production of bioethanol from fruit wastes/sugarcane/corn feedstock.
- Detoxification of Jatropha seed-cake by different methods.
- Production of Biodiesel from plant sources.
- Biodiesel/Biogas set-up.
- Estimation of catalytic activities of enzymes responsible for bio hydrogen production.

References:

S.No.	Name of Book/Author/Publisher
1.	Dalena F, Basile A and Rossi C (2017) - Bioenergy systems for the future (Woodhead Publishing Series)
2	Pandey A, Chang JS, Hallenbeck PC (2013) - Bio hydrogen
3.	Ray Ramesh and Ramachandran S (2018) - Bioethanol production from Food crops: Sustainable sources, Interventions and Challenges
4.	Khanna M, Scheffran J, Zilberman D -Handbook of Bioenergy Economics and Policy

5.	Johnson F, Seebaluck V- Bioenergy for Sustainable development and International competitiveness

INDUSTRIAL PLANT BIOTECHNOLOGY (IBT503)

Details of course : -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Industrial Plant Biotechnology	3	0	2	Nil

Course Objective: The objective of the course is to equip students with the knowledge, skills, and ethical awareness needed to contribute to advancements in plant science and agriculture through the responsible application of biotechnological principles and techniques

Course Outcomes:	
CO1	Understanding the basic principles of plant tissue culture and techniques
CO2	Knowledge of production means and mass cultivation using tissue culturing
CO3	Imparting Knowledge about various techniques used for genetic modifications in plants
CO4	Knowledge of applicability of transgenic in solving various issues faced by humanity
CO5	Learning of regulatory issues and ethical concerns involved in plant genetic engineering

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**3**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

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S. No.	Content	Contact Hours
Unit 1	**Introduction to Plant Tissue Culture:** Cellular totipotency, Micro propagation; Types of culture, Seed culture, embryo culture, Protoplast culture, Cell suspension; In vitro production of haploids; Soma clonal variation; Germplasm storage and cryopreservation.	**9**
Unit 2	**Plant Secondary Metabolite Production:** Formation of Secondary Metabolites in Tissue Culture; Applications of secondary metabolites , industrially important pharmaceuticals, pigments, perfumes, flavors, insecticides, flavonoids; Bioreactor system and models for mass cultivation of plant cells; hairy root culture	**9**
Unit 3	**Gene Transfer in Plants:** Gene cloning; tools of genetic engineering; Vector and vector less gene transfer; Agrobacterium mediated DNA Transformation; status and expression of transferred genes.	**9**
Unit 4	**Transgenic in Crop Improvement:** Resistance to biotic stresses and abiotic stresses; Herbicide resistance; Transgenic for quality, Transgenic plants as bioreactors; commercial transgenic crops and impact of recombinant DNA technology; Therapeutic products; Transgene silencing and ethical issues.	**9**
Unit 5	**Plant Bioinformatics:** Introduction to Plant Bioinformatics and its importance; biological databases, Protein and Gene Information Resources, Plant specific Genomic Data and Resources,	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Bhojwani & Rajdhan, *Animal and Plant Biotechnology,* Elsevier, 1996.
2.	Biotol series, *In vitro Cultivation of Plant cell*, Butterworth Heinemann Ltd., 1994
3.	Lindsey. K and M.G.K. Jones, *Plant Biotechnology in Agriculture*, Prentice Hall, New Jersey, 1990.

PLANT BIOTECHNOLOGY LAB

- Aseptic culture techniques for the establishment and maintenance of cultures
- Preparation of plant tissue culture media
- Establishment of shoot culture
- In-vitro hardening technique for Tissue culture raised plants
- To establish root suspension culture
- To establish cell suspension culture
- Studying the economic factors influencing micro propagation
- Introduction to plant specific databases

ENZYME TECHNOLOGY AND INDUSTRIAL APPLICATION (IBT505)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Enzyme Technology and Industrial Application	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

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Course Outcomes:	
CO1	Understand the concept of Enzyme, nomenclature and its classification.
CO2	Illustrate the kinetics and mechanism of Enzyme.
CO3	Compare and contrast the types of Enzyme Immobilization.
CO4	Identify the Enzyme Reactor for Batch/ continuous enzymatic processing.
CO5	Understand the application of enzymes.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

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PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction to enzymes:** Introduction, nomenclature and classification of enzyme. Mechanism and catalysis, Enzymatic catalysis in biphasic system, Ribozyme, Abzyme (catalytic antibodies), isoenzymes, Coenzymes and cofactors.	**8**
Unit 2	**Enzyme Kinetics:** Kinetics of substrate and multisubstrate reactions; King-Altman's method, Analysis of kinetic data, Inhibition - substrate, product and inhibitors, Active and ligand binding sites, Allosteric, Regulation of enzymes, deactivation kinetics.	**9**
Unit 3	**Enzyme immobilization:** Methods of immobilization, External and Internal diffusional, Mass Transfer Limitation, Effectiveness factor and Modulus.	**9**
Unit 4	**Enzyme Reactor and Purification of enzymes from natural source:** Reactors for Batch/ continuous enzymatic processing, Choice of Reactor type; Production and purification of crude enzyme extracts from Plant, Animal and Microbial sources.	**10**
Unit 5	**Application of enzymes:** Application of enzymes in different Industries (Pulp and Paper industry, Detergent industry, Textile industry, Food Processing industry), Medical and Analytical application of enzyme.	**9**
	Total	**45**

Enzyme Technology & Industrial Application Lab:

- Effect of temperature on enzyme activity
- Studies on Enzyme kinetics
- Effect of pH on enzyme activity
- Glucose estimation by DNS method.
- Enzyme immobilization techniques
- Characterization of Immobilized enzymes and their applications
- Estimation of the amount of protein content in the given sample by Lowry method.

References:

S.No.	Name of Book/Author/Publisher
1	Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis by R.A. Copeland. Publisher: John Wiley and Sons Inc.
2	Enzymes by Palmer (2001): Horwood Publishing Series.
3	Introduction to Biocatalysis using Enzymes and Microorganisms by S.M. Roberts, N.J. Turner and A. J. Willetts. Publisher: Cambridge University Press.
4	Fundamentals of Enzymology by Price and Stevens (2002). Publisher: Oxford University Press.
5	Enzyme Technology by Helmut Uhling (1998). Publisher: John Wiley.
6	Introduction to Proteins Structure by Branden and Tooze (1998). Publisher: Garland Publishing.
7	Enzyme Kinetics: Behaviour and Analysis of Rapid Equilibrium and Steady - State Enzyme Systems by I.H. Segel. Publisher: Wiley-Interscience. (1995)

FUNCTIONAL GENOMICS AND PROTEOMICS
(IBT507)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Functional Genomics and Proteomics	3	0	2	Nil

Course Objective: Empower students to understand and utilize principles, techniques, and applications of functional genomics and proteomics, fostering expertise in Genomic and Proteomic analysis for advancing personalized medicine

Course Outcomes:	
CO1	To appraise various DNA sequencing and genome editing technologies
CO2	To understand the fundamentals of transcriptomic and to appraise various gene expression profiling and knock out techniques
CO3	To comprehend genome-wide protein analysis and protein engineering techniques
CO4	To get insight into various techniques for isolation and analysis of DNA-protein and protein-protein complexes
CO5	To appraise the concept of personalized medicine based on pharmacogenomics

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**3**	**3**
CO 5	**3**	**2**	**3**

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PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Tools in Genomics and Genome Editing:** Next Generation Sequencing techniques; Genome sequencing; DNA fingerprinting; Crispr-Cas9, ZFN, TALEN	**8**
Unit 2	**Transcriptomic & Functional Genomics Tools:** 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	**10**
Unit 3	**Techniques in Proteomics and Protein Engineering:** Protein sequencing; 2D gel electrophoresis; Mass spectrometry; Protein engineering: Rational protein design, Directed evolution	**8**
Unit 4	**Interatomic:** Methods for detecting DNA-protein interactions: Chromatin immunoprecipitation assay, Gel retardation assay, DNase I foot printing, Modification interference assay, DNA pull-down assay, Microplate capture and detection assay, Reporter assays; Methods for detecting protein-protein interactions: Immunoprecipitation, Yeast two-hybrid system and variants, Phage display, GFP tagging, Intein splicing; TAP tagging; Protein chips; Synthetic lethal screens; Yeast genome-wide interaction studies	**10**
Unit 5	**Pharmacogenomics and Personalized Medicine:** Single nucleotide polymorphism; Principle of pharmacogenomics; Case studies for personalized medicine	**9**
	Total	**45**

Practical's:

- Nucleotide databases
- Pairwise sequence alignment
- Sequence similarity
- Multiple sequence alignment
- Phylogenetic analysis
- Gene prediction tools
- RNA prediction tools
- Protein structure prediction
- Polyacrylamide gel electrophoresis
- Analysis of amino acid composition
- Microarray data analysis

References:

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 Ssvelsbergh. Publisher: Humana New York, NY
11.	Genomics and Proteomics: Principles, Technologies, and Applications by D Thangadurai, J Sangeetha. Publisher: Apple Academic

FIRST YEAR (Semester 2)

DEPARTMENT CORE COURSE

ADVANCED ENVIRONMENTAL BIOTECHNOLOGY (IBT502)

Details of course: -

Course Title	**Course Structure**			**Pre-Requisite**
	L	T	P	
Advance Environmental Biotechnology	3	0	2	Nil

Course Objective: To impart knowledge on environmental concepts with focus on water pollution, solid waste management, and bioremediation

Course Outcomes:	
CO1	To provide conservation knowledge and understanding on the concepts of environmental conservation
CO2	To gain understanding on different types, sources and effects of environmental pollution
CO3	To gain understanding on the concepts of bioremediation with focus on in-situ and ex-situ conservation
CO4	To impart knowledge on the understanding of solid waste management and its treatment strategies
CO5	To study effects of effluent and its treatment strategies

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**3**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**3**	**3**
CO 5	**3**	**2**	**3**

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PO2: Ability to write and present a substantial technical report/document.

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S. No.	Content	Contact Hours
Unit 1	**Basic concepts of environment**: Interaction between environment and biota, Limiting factors, Energy flow, food chain, Environmental impact assessment, Principles of conservation, Conservation strategies, sustainable development, Global environmental problems: UV-B radiation, ozone depletion, greenhouse effect and acid rain.	**8**
Unit 2	**Environmental pollution**: Types of pollution and pollution analysis: noise and air pollution. Noise pollution: Types, sources, measurement, impact on ecosystem and control. Air pollution: Types, sources, method of sampling.	**9**
Unit 3	**Bioremediation:** In-situ and ex-situ bioremediation, bioremediation of oil spills and heavy metal pollution, use of microbes in bioremediation, hydroponic system, pollution control boards and pollution control acts.	**9**

Unit 4	**Solid waste management**: Sewage sludge treatment and utilization, composting and vermiculture, bioremediation of contaminated soils and waste lands, radioactive products waste disposal.	**10**
Unit 5	**Effluent treatment:** Sources of effluents, impact on ecosystem and treatment of industrial effluents.	**9**
	Total	**45**

Environmental Biotechnology Lab

- Environmental Impact Assessment, Measurement of Air and Noise Pollution.
- Measurement and control of pH.
- Measurement of Conductivity and TDS in water.
- Measurement of Dissolved Oxygen in a given water sample.
- Measurement of Carbon dioxide and Hardness of water.
- Analysis of Ammonia and Ammonium in water.
- Analysis of Nitrite, Nitrate and Total Nitrogen in water.
- Measurement of Biochemical Oxygen Demand and Chemical Oxygen Demand.
- Analysis of industrial effluent.
- Biogas production/Vermicomposting.

References:

S.No.	Name of Book/Author/Publisher
1.	Bruce E. Rittmann and perry L. Mccarty., "Environmental Biotechnology: Principle and Applications", McGraw Hill publishing company Ltd, 2001.
2.	Des W. Connell, "Basic concepts of Environmental chemistry", Lewis publishers, 2005
3.	Richard T. Wright and Bernard J. Nebel., "Environmental Science towards a Sustainable Future", Prentice Hall of India. 2004

BIOSAFETY, BIOETHICS & IPR (IBT504)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Biosafety, Bioethics & IPR	3	1	0	Nil

Course Objective: This course provides a comprehensive overview of bioethics and intellectual property rights in biotechnology and related fields.

Course Outcomes:

CO1	Understanding the significance of intellectual property and biosafety principles.
CO2	Mastering the concept of & "prior art and proficiently conducting patent searches.
CO3	Gaining knowledge of patent basics and procedures for effective patent filing.
CO4	Developing practical skills in patent filing and understanding patent infringement.
CO5	Comprehending biosafety principles and regulations governing production and use of GMO release.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**3**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

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PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction to ethics and bioethics:** Personal ethics: profession and professionalism, Biotechnology and ethics: Biotechnology in agriculture and environment: benefits and risks.	**9**
Unit 2	**Introduction to intellectual property:** Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IPR	**9**

Unit 3	**Basics of patents:** Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure.	**9**
Unit 4	**Patent filing and infringement patent application:** Forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; International patenting, Patent infringement	**9**
Unit 5	**Biosafety introduction:** Good Lab Practices, Introduction to Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety Levels GMOs and LMOs and their environmental impact.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	IPR biosafety and bioethics by Goel And Parashar; publisher : Pearson Education India
2.	http://www.wipo.int/portal/index.html.en
3.	www.patentoffice.nic.in

SECOND YEAR (III SEM)
DEPARTMENT CORE COURSE
BIOPROCESS ENGINEERING & REACTOR DESIGNING
(IBT601)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Bioprocess Engineering & Reactor Designing	3	0	2	Nil

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 Outcomes:	
CO1	Understand the basics of media design and sterilization kinetics.
CO2	Summarize the metabolic stoichiometry and microbial Growth kinetics.
CO3	Compare and contrast the type and design of bioreactor.
CO4	To gain knowledge about Instrumentation and its control.
CO5	To gain insight to the working of downstream processes at an industrial scale.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**3**	**2**	**3**
CO2	**3**	**3**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Media design and Sterilization kinetics:** Criteria for good medium, medium requirements for fermentation processes, Thermal death kinetics of microorganisms, Batch and Continuous heat sterilization of liquid Media, air sterilization.	**8**

Unit 2	**Metabolic stoichiometry Growth kinetics and energetic:** Stoichiometry of cell growth and product formation, elemental balances, Monod model, growth of filamentous organisms, product formation kinetics, substrate and product inhibition on cell growth and product formation, Heterogeneous reactions.	**9**
Unit 3	**Types and design of bioreactor:** Design and operation of various bioreactors, viz CSTF, fed batch systems, air-lift bioreactors, fluidized bed, plug Flow and Packed Bed Bioreactor; Performance equations.	**9**
Unit 4	**Instrumentation and Control:** Biochemical process variables and their measurements; Microbial biosensors, Use of computer in control and optimization of microbiological processes.	**10**
Unit 5	**Downstream processing:** Removal of microbial cells and solid matter, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and Crystallization.	**9**
	Total	**45**

List of Experiments:

- Determination of growth curve of a given microorganism
- To determine the concentration of protein content by Lowry method.
- To determine the concentration of sugar by 3, 5 di-nitro salicylic acid method.
- To determine the optimum pH for a given enzyme sample.
- To determine the optimum temperature for a given enzyme sample
- To study the immobilization of invertase enzyme.
- Preparation of microbial growth curve.
- Production of ethanol from sugar by yeast fermentation.

References:

S.No.	Name of Book/Author/Publisher
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)
5.	Bioprocess Engineering Basic Concepts by M.L. Shuler and F. Kargi. Publisher: Prentice Hall (1987)
6.	Biochemical Engineering Fundamentals by J.E. Baily and D.F. Ollis. Publisher: McGraw Hill. (1986)

DEPARTMENT ELECTIVE COURSE (SEMESTER 1)

ELECTIVE 1

INDUSTRIAL WASTEWATER TREATMENT (IBT511)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Industrial Wastewater Treatment	3	1	0	Nil

Course Objective: To impart knowledge on sources of industrial waste, their treatment strategies and future prospects

Course Outcomes:	
CO1	To impart knowledge on the sources of solid waste, industrial waste effluents
CO2	To gain understanding on different characteristics of waste and toxic byproducts formed
CO3	To study small and large scale remediation of industrial waste
CO4	To gain understanding on different microbes used for wastewater remediation
CO5	To learn about the advanced treatment technologies for industrial wastewater treatment

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**3**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours

Unit 1	**Waste disposal:** Waste disposal management, Methods of waste disposal, effect of industrial wastes on streams and sewerage systems, physico-chemical and biological treatments of waste and their evaluation in respect of treatment.	**8**
Unit 2	**Industrial waste:** Characteristic features of wastes (solid, liquid and gaseous emission), toxic byproducts generated from paper and pulp industries, thermal power station, distillery, textile industry.	**9**
Unit 3	**Waste remediation:** Small and large scale industries for waste reduction and remediation, various methods for waste alteration, recycling plants, material restoration and conservation. Economic sustainability and government support for joint treatment of raw effluent, municipal sewage and debris.	**9**
Unit 4	**Microbiology of waste**: Microbiology of Wastewater treatment. Different microbes responsible for Wastewater treatment.	**10**
Unit 5	**Advanced Treatment**: Advanced technologies of Wastewater treatment: Softening, Ion exchange, Reverse Osmosis Technologies, Ultrafiltration, Selective membrane	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	S. P. Mahajan, “Pollution Control in Process Industries”, Tata McGraw Hill Publications.
2.	W. Wesley Eckenfelder Jr.,” Industrial Water Pollution Control”, McGraw Hill Publications.
3.	Ronald W. Crites Sherwood C. Reed and Robert Bastion, “Land Treatment Systems for Municipal & Industrial Wastes” McGraw 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.
6.	Dr. A. D. Patwardhan, “Industrial WasteWater Treatment”. Prentice Hall of India.

BIOINFORMATICS (IBT513)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Bioinformatics	3	0	2	Nil

Course Objective: This course aims to provide students with foundational knowledge in bioinformatics, emphasizing algorithmic concepts and practical applications.

Course Outcomes:	
CO1	Identify and utilize various biological databases; understand database types, sequence formats, retrieval methods, and submission protocols.
CO2	Understand the basics of genomics, including the significance of the Human Genome Project.
CO3	Develop and execute programming skills necessary for bioinformatics.
CO4	Conduct pairwise sequence Alignment using appropriate scoring matrices: - and understand underlying algorithm.
CO5	Execute Multiple Sequence Alignment and understand the associated algorithms.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Overview of Biological Databases:** Key databases and their types including NCBI tools like PubMed, Entrez, Blast, OMIM, and Protein Databases.	**8**
Unit 2	**Foundations of Genomics:** DNA structure, DNA sequence polymorphisms, insights from the Human Genome Project, complete genome sequences, and functional annotation.	**9**
Unit 3	**Bioinformatics Programming:** Introduction to essential programming languages, covering functions, data types, structures, operators, conditionals, loops, lists, arrays, and file handling.	**9**
Unit 4	**Pairwise Sequence Alignment:** Techniques and algorithms for local and global alignment, including the use of PAM and BLOSUM scoring matrices: -, and exploration of Needleman-Wunsch and Smith-Waterman algorithms.	**10**
Unit 5	**Multiple Sequence Alignment:** Analysis of scoring matrices: -, gap penalties, tools for multiple sequence alignment, and implications for structural inference.	**9**
	Total	**45**

Practical's:

1. To explore and utilize biological databases like PubMed, Entrez, BLAST, OMIM, and protein databases.
2. To visualize DNA structure, analyze SNP data, investigate the Human Genome Project, and annotate gene sequences.
3. To develop Python programs for bioinformatics tasks, including reading sequence data, calculating GC content, and parsing FASTA files.
4. To develop Python programs for bioinformatics tasks, including reading sequence data, calculating GC content, and parsing FASTA files.
5. To conduct and analyze multiple sequence alignments using tools like Clustal Omega, and draw structural and functional inferences.

References:

1.	Hasija, Y., "All About Bioinformatics: From Beginner to Expert", 2023
2.	Hasija, Y., Chakraborty, R., "Hands on Data Science for Biologists Using Python", 2021.
3.	Hasija, Y. (Editor), "Translational Biotechnology: A Journey from Laboratory to Clinics", 2021.
4.	Shaik, N., "Essentials of Bioinformatics, Volume II: In silico Life Science: Medicine", 2019.

5.	Tan, T. W., Lee, E. C., "Beginners Guide To Bioinformatics For High Throughput Sequencing", 2018.

CELL & MOLECULAR BIOLOGY (IBT515)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Cell & Molecular Biology	L	T	P	
	3	0	2	Knowledge of cell structure and biomolecules

Course Objective: To give a detailed perspective of cell communication, proliferation, gene expression and silencing, and basic techniques used in Cell & Molecular Biology

Course Outcomes:	
CO1	To learn the mechanisms of biological processes involved in gene expression
CO2	To explain the concept of cell cycle and cell division and the impact of excessive cell proliferation
CO3	To comprehend mechanisms of cellular signaling and protein targeting within the cell or to the cell exterior
CO4	To gain insight into the strategies for gene silencing
CO5	To appraise various Cell & Molecular Biology techniques

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**2**	**3**
CO4	**3**	**3**	**3**
CO 5	**3**	**3**	**3**

PO1: Ability independently carries out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Gene Expression:** Mechanisms in DNA replication, transcription, post-transcription, translation, post-translation; Operon	**9**
Unit 2	**Cell Proliferation:** Cell Division; Apoptosis; Proto-oncogenes and tumor-suppressor genes in cancer	**8**
Unit 3	**Cell-Cell Communication and Protein Trafficking:** Junctions; Extracellular matrix; Cell adhesion molecules; Cellular signaling; Protein targeting; Vesicular trafficking; Coated vesicles; Structure of cell membrane; Transport across membrane; Receptor-mediated endocytosis	**10**
Unit 4	**Gene Silencing:** Transcriptional and post-transcriptional gene silencing; Antisense RNA technology; RNA interference; Trans-acting ribozymes; Case studies	**8**
Unit 5	**Cell & Molecular Biology Techniques:** FACS; Agarose gel electrophoresis; Polyacrylamide gel electrophoresis; Southern blot hybridization; Northern hybridization; Western blotting; Polymerase Chain Reaction; DNA fingerprinting	**10**
	Total	**45**

References:

S.No.	Name of Book/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 Kreb's et al. Publisher: Jones & Bartlett Learning
4.	Cell and Molecular Biology by P Khanna. Publisher: IK Intl.
5.	Cell and Molecular Biology by M Jacob. Publisher: CBS
6.	Karp's Cell and Molecular Biology by G Karp, J Iwasa, W Marshall. Publisher: John Wiley and Sons, Inc.
7.	The Cell: A Molecular Approach by GM Cooper, RE Hausman. Publisher: Sinauer Associates Inc.
8.	Molecular Biology of the Cell by B Alberts, R Heald, A Johnson, D Morgan, M Raff, K Roberts, P Walter. Publisher: Garland Science
9.	Molecular Cell Biology by H Lodish, A Berk, CA Kaiser, M Krieger, A Bretscher. Publisher: WH Freeman

Practical's

- Genomic DNA isolation
- Electrophoretic analysis of DNA

- Quantitative determination of DNA
- DNA purity determination
- Quantification of DNA by UV spectrophotometric analysis
- Quantification of RNA
- Elution of DNA from gel
- Polymerase Chain Reaction
- Cell sorting

RECOMBINANT DNA TECHNOLOGY (IBT517)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Recombinant DNA technology	3	1	0	Nil

Course Objective: This course provides an in-depth exploration of recombinant DNA technology, focusing on the principles, techniques, and applications of manipulating DNA. Students will study gene cloning, expression, and editing, as well as applications in medicine, Agriculture and industry

.

Course Outcomes:	
CO1	Understand the fundamental concepts of recombinant DNA technology
CO2	Learn Key techniques for gene cloning, expression and editing
CO3	Explore the applications of recombinant DNA technology in various fields
CO4	Analyze the ethical and regulatory considerations in recombinant DNA research
CO5	Conduct research and present findings on a specific topic in recombinant DNA technology

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

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PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Cloning Vectors:** Ideal features of cloning vectors; plasmids and bacteriophages; cloning vectors for *E. coli;* pBR322, pUC vectors, M13 and other plasmid vectors, Cosmids, Phagemids; vectors for Bacillus, Streptomyces Restriction mapping and analysis	**9**
Unit 2	**Enzymes and Techniques for Cloning:** DNA modifying enzymes, ligases, Nucleic acid probe preparation; Radioactive and nonradioactive labels – Hybridization techniques – PCR; different types and applications – DNA sequencing – DNA fingerprinting – RFLP, RAPD – chromosome walking.	**9**
Unit 3	**Expression Vectors:** Expression vectors in prokaryotes; Expression vectors in Eukaryotes;Yeast cloning vectors ;selectable markers for eukaryotes, SV40, Papilloma, Retrovirus, Baculoviral vectors; mammalian cell expression system; Gene transfer techniques – Agrobacterial Plasmids ; Ti plasmid and viral vectors ; cloning in plants.	**9**
Unit 4	**Genomic and cDNA Library:** Different strategies for in vitro and in vivo cloning ; Preparation of rDNA, Preparation of cDNA and genomic DNA libraries ;screening procedures ; linkers, adapters, homopolymer tailing and TA cloning ; gene transfer technologies ; Mutagenesis ,site directed mutagenesis ,application	**9**
Unit 5	**Application of gene cloning:** Down-stream processing of recombinant proteins, Applications in medicine, Gene therapy, Diagnostics, pathogenesis, recombinant vaccines , bioremediation with recombinant microorganisms– forensic science, genetic diversity ,Agriculture, crop improvement, production of biosensors, enzymes, safety guidelines in rDNA research, containment and disposal.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Jeremy W. Dale, Malcolm von Schantz, Nicholas Plant. From Genes to Genomes: Concepts and Applications of DNA Technology-3rd Edition. 2011. Wiley-Blackwell.
2.	Michael R. Green and Joseph Sambrook. Molecular Cloning: A Laboratory Manual (Fourth Edition). 2012. Cold Spring Harbor Press.

3.	Jocelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick. Lewin's GENES XI. 2012. Jones & Bartlett Learning

NEUROBIOLOGY (IBT519)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Neurobiology	L	T	P	
	3	1	0	NIL

Course Objective: The objective is to introduce students to the fundamental principles of neuroscience including neuronal structure and function, neural communication, and the organization of nervous system

.

Course Outcome:	
S. No.	
CO1	Understand brain structure, synapses, receptors, and neurotransmitter functions.
CO2	Explain molecular/cellular neurobiology, neural development, and neuroplasticity principles.
CO3	Define, analyze pathophysiology, treatments, and societal impact of neurodegenerative disorders.
CO4	Describe neuromuscular junctions, pathophysiology, treatments, and neuron-muscle interplay
CO5	Explain neuroprotection, neuroprosthetics, neuroinformatics, treatments, and future directions.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	Introduction: Fine structure of the brain and its function, synapses, receptors and neurotransmitters	09
Unit 2	Basic neuroscience: molecular and cellular neurobiology and basic knowledge of general neurobiology	09
Unit 3	Neurodegenerative disorders: General description, Alzheimer's disease, Huntington's disease, Poly Q disorders, Amyotrophic Lateral 09Sclerosis (ALS)	09
Unit 4	Cross-talk between neurons and muscles: Parkinson's disease, Inclusion body myositis (IBM), Polymyositis (PM)	09
Unit 5	Neurotherapeutics and Neuroinformatics: Action of biomolecules in neuroprotection, Neuroprosthetics	09
	Total	45

References:

S.No.	Name of Book/Author/Publisher
1.	Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. Neuroscience: Exploring the Brain, 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2006. ISBN: 9780781760034
2.	Duane E. Haines PhD FAAAS FAAA (Author), Gregory A. Mihailoff PhD Fundamental Neuroscience for Basic and Clinical Applications, Elsevier
3.	Neuroscience (English, Hardcover, Bear Mark F.), Publisher: Lippincott Williams and Wilkins, ISBN: 9780781778176, 0781778174, Pages: 1008

SEMESTER II
ELECTIVE 2

INDUSTRIAL MICROBIOLOGY AND FERMENTATION TECHNOLOGY (IBT520)

Details of course: -

Course Title	**Course Structure**			**Pre-Requisite**
	L	T	P	
Industrial Microbiology & Fermentation Technology	3	1	0	Nil

Course Objective: To provide the theoretical and practical bases to set-up, manage and improve microbial processes, for the industrial production of compounds.	
Course Outcomes:	
CO1	Understand the basics of Inoculum Development and Media Preparation
CO2	Compare and contrast Process technology for Primary and Secondary metabolites
CO3	Summarize the Sterilization and Cell growth kinetics
CO4	To gain insight of the Fermentation Process
CO5	Understand the design of Fermenter and its control

CO-PO Articulation matrices: -

Course	**PO 1**	**PO 2**	**PO 3**
CO1	**3**	**2**	**3**
CO2	**2**	**2**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Inoculum Development and Media Preparation**: Media components and optimization, types of culture media, Isolation, screening, Selection of mutants; Development of inocula for industrial fermentation.	**8**
Unit 2	**Process technology for Primary and Secondary metabolites:** Production of primary metabolites - Ethanol from molasses, citric acid, amino acids, Baker's yeast, polysaccharides and peptides and plastics; Antibiotics, metabolites from plant cell culture.	**9**
Unit 3	**Sterilization and Cell growth kinetics:** Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, air sterilization, Microbial growth kinetics, logistic growth model, growth of filamentous organism.	**9**
Unit 4	**Fermentation Process:** Parts of fermenter: Body, Baffles, Sparger, valves, ports, Aeration: Oxygen requirement, Oxygen uptake in cell culture, Oxygen transfer in fermenter**,** gas hold up, Measurement of KLa, Factors effecting KLa in fermenter.	**10**
Unit 5	**Control of Fermenter:** Requirements for control, sensors, controllers, Design of fermenter control specification.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Presott& Dunn's Industrial Microbiology. Ed. E.G. Reed (1987). CBS Publishers, New Delhi.
2.	Microbiology, Pelzar Jr. M.J.: Chan E.C.S. and Krieg, N. R. (1993) Tata McGraw Hill, New Delhi.
3.	Stanbury, Whitaker and Hall, "Principles of Fermentation Technology", Butterworth Heinemann, 2nd Ed., 1999.
4.	Pauline M. Doran, "Bioprocess Engineering Principles", Academic Press, 2nd Ed., 2012.
5.	Industrial Microbiology, Casida Jr. L. E. 1968) new Age International (P) Ltd. New Delhi.

FOOD ENGINEERING AND BIOTECHNOLOGY
(IBT522)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Food Engineering & Biotechnology	L	T	P	
	3	1	0	Nil

Course Objective: To understand the concepts of food nutrition, packaging, storage and packaging with standard quality

Course Outcomes:	
CO1	To gain knowledge on the concepts of food chemistry and nutrition
CO2	To impart understanding on the macromolecules involved in human nutrition
CO3	To study different fermentation products involved in food
CO4	To gain understanding on the concepts of food storage and packaging
CO5	To understand the concepts of food standard quality parameters and techniques

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**3**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Food chemistry**: Food chemistry-definition and importance, Composition of foods and function of water, carbohydrates, proteins, amino acids, lipids, vitamins and shelf life of food. Bioavailability and stability of nutrients, Nutritive value of foods, Food as a source of energy, Food Health and diseases.	**8**
Unit 2	**Standards for food analysis**: Standards of identity, purity, and methodology for analysis of a) Cereals, legumes, oil seeds and their products; b) Fruits, vegetables, tubers, and their products; c) Tea, coffee, cocoa, chocolate, spices, sugar, condiments; d) Milk and milk products; e) Meat, fish and poultry products; f) Miscellaneous foods e.g., fermented products.	**9**
Unit 3	**Chemical Analysis**: Analysis of chemical constituents, their characterization and significance; Application of modern techniques including spectroscopy, chromatography including GC, GC –MS, HPLC, HPTLC, gel permeation, ion-exchange	**9**
Unit 4	**Food Preservation and storage:** General principles underlying spoilage and chemical changes of food caused by microorganisms, food spoiling enzymes, toxin production and deterioration of foods. Principles of food preservation; by physical methods; by chemical methods and biological methods	**10**
Unit 5	**Food Processing and Quality assurance:** Basic principles, unit operations, and equipment involved in the commercially important food processing methods and unit operations; materials and containers used in food packaging. Objectives, importance and functions of quality control. Methods of quality, assessment of food materials-fruits, vegetables, cereals, dairy products, meat and poultry.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Frazier, W.S. and Weshoff, D.C., Food Microbiology, 4th Edn., McGraw Hill Book Co., New York, 1998
2.	Mann & Trusswell , Essentials of human nutrition. 3rd edition .oxford university press, 2007
3.	Prescott and Dunn, Gerald Reed, Industrial Microbiology, 4th Edition, AVI Publishing Company Inc. Connecticut 1983
4.	B.Sivashankar – Food processing and preservation, Prentice – Hall of India Pvt.Ltd. New Delhi 2002

BIOPOLYMER TECHNOLOGY (IBT524)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Biopolymer Technology	L	T	P	
	3	1	0	Nil

Course Objective: The objective of this course it to gain insight to biopolymer technology, different types, and applications

Course Outcomes:	
CO1	**Understand the about Biopolymers, types, characteristics**
CO2	List the applications of Biopolymers
CO3	Illustrate the source characteristics of Biosurfactants
CO4	Gain insight of Bioplatics and its synthesis
CO5	Demonstrate the material testing and analytical methods

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3:Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction** Biopolymers – The current scenario, different biopolymers – produced from various renewable resources, characteristics, merits and demerits over conventional polymers	**8**

Unit 2	**Biopolymer Technology and Applications** Biopolymers and Artificial Biopolymers in Biomedical Applications, an Overview, Novel Synthesis of Biopolymers and Their Medical Applications, Composite Films Based on Poly (Vinyl Alcohol) and Lignocellulosic Fibres: Preparation and Characterizations, Composite Materials Based on Gelatin and Fillers from Renewable Resources: Thermal and Mechanical Properties, Properties of PHAs and Their Correlation to Fermentation Conditions	**9**
Unit 3	**Bio surfactants** Source, characteristics and properties of Bio surfactants; Production of Bio surfactants via the fermentation and biotransformation routes; Production of Bio surfactants with immobilized cells; Integrated bioprocess for continuous production of Bio surfactants including downstream processing; Applications of Bio surfactants-Food Industry, Environmental Control.	**9**
Unit 4	**Bioplastic** Different types of bioplastics; Starch-based plastic, Cellulose-based plastic. Aliphatic polyesters; Poly-3-hydroxybutyrate (PHB), Polylactic acid (PLA). Polyamide. Bio-derived polyethylene Advantages of bioplastic over petroleum-based polymer Mechanism of synthesis of Poly(b- hydroxybutyric acid) (PHB)	**10**
Unit 5	**Material Testing and Analytical Methods** An Overview of Available Testing Methods, Comparison of Test Systems for the Examination of the Fermentability of Biodegradable Materials, Structure- Biodegradability Relationship of biopolymers.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Emo Chiellini , Emo Chiellini and Helena Gil**,** Biorelated Polymers: Sustainable Polymer Science and Technology, Springer 2001
2.	Johnson .R.M, L.Y. Mwaikambo and N. Tucker, Biopolymers**,** Rapra Technology, 2003.
3.	Naim Kosaric (Ed). Biosurfactants. Marcell Dekker Inc, 1993

PLANT MOLECULAR PHARMING (IBT526)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Plant Molecular Pharming	L	T	P	
	3	1	0	Nil
Course Objective: This course provides a comprehensive overview of plant molecular farming, focusing on the use of plants as platforms for the production of pharmaceuticals and other valuable compounds.				

Course Outcomes:	
CO1	Understand the principles of plant molecular farming.
CO2	Learn about the genetic engineering of plants for pharmaceutical production.
CO3	Explore applications of plant molecular farming in medicine and industry
CO4	Analyze the ethical and regulatory considerations in plant molecular farming
CO5	Conduct research and present findings on a specific topic in plant molecular farming

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

CO-PO Articulation matrices: -

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

Note: Program mat add up to three additional POs approved by BOS of the department.

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Definition and common perception of molecular farming; Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance & advantages of plant-based molecular farming.	**9**
Unit 2	**Strategic Components of Various Molecular Farming:** Carbohydrate and lipid molecular farming; Introduction to the crucial metabolic pathways; Various molecular approaches & strategies relevant to molecular farming; Production of carbohydrates: increased starch amount, Amylose-Free Starch, High-Amylose Starch, Cyclodextrins, Fructans, Trehalose	**9**
Unit 3	**Production of Lipids:** Medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, polyunsaturated fatty acid shaving pharmaceutical and nutraceutical values	**9**
Unit 4	**Production of Biodegradable Plastics in Plants:** Various gene functions involved in the production of Polyhydroxy Butyrate (PHBs) & Polyhydroxy Alkanoate co-polymers; Strategies for production of Biodegradable plastics in plants.	**9**
Unit 5	**Genetically Engineered Plants for Pharmaceutical Production:** The Oleosin system: insulin production, production of biopharmaceuticals in plants; Chloroplast: a clean high-level expression system for molecular farming based on single or multiple transgenes	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Slater A, Scott NW and Fowler MR, Plant Biotechnology, Oxford University Press (2008).
2.	Primrose SB and Twyman RM, Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).
3.	Satyanarayana U, Biotechnology, References and Allied (P) Ltd. (2005)

NANOBIOTECHNOLOGY (IBT528)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Nano biotechnology	L	T	P	
	3	1	0	Nil

Course Objective: The objective of this course is to impart interdisciplinary education in nanoscience and Nano biotechnology. The aim of this advanced course is to provide understanding for various Nano biotechnological applications

Course Outcomes:	
CO1	Understand the basics concepts of nanoscience and its applications.
CO2	Illustrate the synthesis process and mechanism of nanomaterials.
CO3	Applications of different types of nanomaterials and its compositions.
CO4	Illustrate the applications of Nano biotechnology.
CO5	Understanding the toxicological effects of nanomaterials and its management.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**3**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction** Nano - definition, The fundamental Science behind nanotechnology- electrons, atoms and ions, molecules, metals, Biosystems Synthesis and Characterizations of Nanoscale Materials. Strategies for Nano architecture (top down and bottom up approaches), Fabrication Technologies and MEMS.	**8**
Unit 2	**Nano-structured materials**. Fullerenes - Properties and Characteristics. Carbon Nanotubes - Characteristics and Applications Quantum Dots and Wires. Gold Nanoparticles. Nano pores, carbon nanotubes Applications of Nano Molecules in Biosystems.	**9**
Unit 3	**Structural and functional principles of Nano biotechnology-**Structural principle: Factors governing biomolecular structure and stability, Protein folding; Self-assembly, Self-organization, Molecular recognition and Flexibility of biomaterials, Structure and functional properties of Biomaterials, Functional principles of Bio nanotechnology: Information driven Nano assembly, Energetics, Bimolecular motors: ATP Synthetase and flagellar motors.	**9**
Unit 4	**Application of Nano biotechnology-**Nano-biotechnology in Drug Delivery. Nanoscale Devices for Drug Discovery. Micelles for Drug Delivery. Protein targeting: Small Molecule-Protein Interactions. Nanotechnology for Cancer Diagnostics and Treatment, Micro-array and Lab-on-a-Chip.	**10**
Unit 5	**Nano toxicology:** Principles of toxicology; toxicology models, experimental toxicology studies; activation and detoxification mechanisms. **Applications, Risks and Precautions**: In vivo diagnosis, in vitro diagnosis, therapy, cosmetics; Environmental and Risk Prevention; Risks and Ethical considerations.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	NANO by T.Pradeep, 2006.Tata Mc Graw Publishers. India
2.	Nanobiotechnology**:** Concepts, Applications and Perspectives, Christof M.Niemeyer, / Chad A.Mirkin, (eds.), Wiley-VCH, Weinheim, (2004)
3.	Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005)
4.	David S Goodsell , Bionanotechnology, John Wiley & Sons, 2004.
5.	Greco Ralph S , Nanoscale Technology in Biological Systems, CRC Press, 2005.

SEMSTER -2

ELECTIVE 3

BIOSENSOR TECHNOLOGY (IBT530)

Details of course: -

Course Title	**Course Structure**			**Pre-Requisite**
Biosensor Technology	L	T	P	
	3	1	0	Nil
Course Objective: The objective of this course is to impart education in Bio sensing technology, their working, applications and future perspective.				

Course Outcomes:	
CO1	Define biosensors and understand its history, properties, design features and the biological component.
CO2	Distinguish between different type of biosensors like aerometric and potentiometric biosensor and detecting of various cations using calorimetric biosensor
CO3	Show overview of sensors and transducers measurement systems their Classification and Important design considerations
CO4	List examples of biosensors with the relatable opportunities and obstacles. And also learning about miniaturized devices designing in Nano biotechnology
CO5	Discuss the Future of Biosensors and Transducers and The importance of computers in sensor and transducer technology,

CO-PO Articulation matrices: -

Course	**PO 1**	**PO 2**	**PO 3**
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction** A historical perspective; Definition and Expanding Needs of Biosensors; Advantages and limitations; Biosensor Economics; various components of biosensors	**8**
Unit 2	**Types of Biosensors** Biocatalysts based biosensors, bio affinity based biosensors & microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions	**9**
Unit 3	**Transducers in Biosensors** Various types of transducers; principles and applications; Bio-, chemi-, and lector chemiluminescence for fiber-optic biosensors; Fluorescence-based fiber-optic biosensors	**9**
Unit 4	**Electrical Signal Detection in Biological Systems** Silicon, glass and metal electrodes, amplifier design. Bioelectronics device production: microelectronic fabrication methods as adapted to bioelectronics, hard and soft lithography, bio-compatibility of materials. Existing types of Biosensors: Miniaturization and micro-systems including sensing using optical techniques, field effect transistors, ion-selective and enzymatic sensitive electrodes, as well as impedance monitoring. Deriving a complete kinetic model; Kinetic modeling in other types of biosensors- Potentiometric enzyme electrodes, Optical and photometric biosensors, Immunosensors	**10**
Unit 5	**Application and Uses of Biosensors-**Biosensors in medicine and health care (For glucose monitoring and for DNA analysis. Analysis of the neural cell impulse signal and neural signal processing) biosensors for agriculture and food; Low cost- biosensor for industrial processes for online monitoring; biosensors for environmental monitoring.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Rajmohan Joshi, Biosensors (1e), Gyan References, 2006
2.	Cooper J.M. and Anthony E.G, Biosensors (2e), Oxford University Press, 2004.
3.	Turner A.P.F, Karube.I and Wilson,G.S, Biosensors Fundamentals and applications, Oxford Univ. Press, 1990
4.	Sadana.A, Biosensors: Kinetics of Binding and Dissociation Using Fractals (1e), Elsevier B.V, 1995
5.	Ashok M and Kim Rogers, Enzyme & Microbial Biosensors: Techniques and Protocols (Methods in Biotechnology) (1e), Humana Press, 1998.
6.	Ashok M and Kim Rogers, Affinity Biosensors: Techniques and Protocols (Methods in Biotechnology) (1e), Humana Press, 1998
7.	Damia Barcelo, Biosensors for the Environmental Monitoring of Aquatic Systems: Bioanalytical and Chemical Methods for Endocrine Disruptors (1e), Springer, 2009.

BIOINSTRUMENTATION (IBT532)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Bioinstrumentation	L	T	P	
	3	1	0	Nil

Course Objective: Development of technologies that measure and manipulate biological systems. It involves the use of instruments to record and transmit physiological information

.

Course Outcomes:	
CO1	Discuss the principle of centrifugation and its types.
CO2	List uses of electrophoretic techniques underlying electrophoresis systems.
CO3	Discuss chromatographic methods.
CO4	Explain spectroscopic and diffraction techniques.
CO5	Define optical techniques like microscopy.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Centrifugation: Basic principle and application,** Analytical and Preparative centrifuges and ultra-centrifugation.	**8**
Unit 2	**Electrophoretic Techniques:** Paper and gel electrophoresis, Immuno electrophoresis, isoelectric focusing, two-dimensional electrophoresis, capillary electrophoresis.	**9**
Unit 3	**Chromatographic Methods:** Paper, TLC gas chromatography, gel filtration, ion exchange chromatography, affinity chromatography and HPLC, FPLC.	**9**
Unit 4	**Spectroscopy:** UV, visible and NIR, spectrofluorimetry, Atomic absorption spectrophotometry, , Atomic absorption spectrophotometry, Mass Spectrometry, Infrared and Raman Spectroscopy, Nuclear Magnetic Resonance and Electron Spin Resonance Spectroscopy.	**10**
Unit 5	**Microscopy:** Principle, parts, types and functioning of Microscope, Optical and Electron Microscopy, Transmission and Scanning Electron Microscopy, Fluorescence microscopy, Confocal microscopy.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Principles and Techniques of Practical Biochemistry by Keith Wilson and JohnWalker, 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 InternationalPublishers.
4.	Introduction to Spectroscopy by D.L. Pavia, G.M. Lampman and G. S. Kriz. Publisher: Brooks Cole
5.	Physical Chemistry of Macromolecules by C. Tanford. Publisher: John Wiley and Sons Inc.

Immunology and Vaccine Technology (IBT534)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Immunology and Vaccine Technology	3	1	2	Nil

Course Objective: To give an overview of the basic concepts in immunology and the development of diagnostic and therapeutic techniques.

Course Outcomes:	
CO1	Understanding innate and adaptive immunity and exploring their role in immune response to pathogens.
CO2	Exploring the role of innate immunity as the first line of defense
CO3	Analyzing the role of the adaptive immune system in complex immune therapeutics
CO4	Identifying autoimmune disease, hypersensitivity reactions, mechanisms of autoimmunity, tolerance, and immunodeficiency's.
CO5	Equip students with the knowledge for application in healthcare and disease management

CO-PO Articulation matrices: -

Course	**PO 1**	**PO 2**	**PO 3**
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S.No	Content	Contact Hours
Unit 1	**Introduction and overview of the Immune system** 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.	10
Unit 2	**Innate immune system** 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.	8
Unit 3	**Adaptive immune system** 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.	8
Unit 4	**Tolerance, Autoimmunity and Hypersensitivity** Central and peripheral tolerance, Autoimmunity causes and treatment, systemic & local autoimmune disease, hypersensitivity, and its types.	8
Unit 5	**Vaccine Technology** Formulation of Vaccines; Types of vaccines; Clinical trials; case studies of different types of vaccines	11
	Total	45

Practical:

- Identify primary and secondary lymphoid organs using permanent slides and understand their histological features and functions.
- Study of Radial Immuno diffusion as a diagnostic tool.
- Study of Double Immuno diffusion as diagnostic tool.
- Blood smear identification of leucocytes by Giemsa stain
- Elucidating Antibody titre by ELISA method.
- Elucidation of advanced techniques of immune diagnostics like Immuno-electrophoresis
- Blood smear identification of leucocytes by Giemsa stain
- Separation of mononuclear cells by Ficoll-Hypaque
- Study of Flow cytometry, identification of T cells and their subsets using Flow cytometry
- Identification of blood groups using agglutination

References: -

S.No.	Name of References/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

METABOLIC ENGINEERING (IBT536)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Metabolic Engineering	L	T	P	
	3	1	0	Nil

Course Objective: This course provides a comprehensive overview of metabolic engineering, focusing on the manipulation of metabolic pathways within cells to optimize the production of desired compounds

Course Outcomes:	
CO1	Understand the principles and techniques of metabolic engineering.
CO2	Learn about metabolic pathways and their regulation
CO3	Explore applications of metabolic engineering in various industries.
CO4	Analyze the ethical and regulatory considerations in metabolic engineering
CO5	Conduct research and present findings on a specific topic in metabolic engineering.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Cellular metabolism:** An overview of cellular metabolism-transport processes- Fueling reactions -glycolysis-fermentative pathways-TCA cycle and oxidative phosphorylation-anapleroticpathways -catabolism of fats, organic acids and amino acids -biosynthetic reactions of amino acids – nucleic acids, fatty acids and other building blocks.	**9**
Unit 2	**Comprehensive models for cellular reactions** Stoichiometry of cellular reactions rates-dynamic mass balances, Yield coefficients and linear rate equation; Material Balance and data consistency ,black box model elemental balance ,heat balance ,analysis of overdetermined systems ,identification of gross measurement errors.	**9**
Unit 3	**Regulation of metabolic pathways:** Overview of enzyme kinetics, simple reversible inhibition systems, irreversible inhibition, allosteric enzymes; cooperativity, regulation of enzyme concentration,Transcription initiation, translation; regulation at whole cell level , regulation of metabolic networks.	**9**
Unit 4	**Metabolic flux analysis:** Theory, overdetermined systems, underdetermined systems, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labelling direct flux determination from fractional enrichment; applications involving complete enumeration of metabolite isotopomers; carbon metabolite balances. Applications of metabolic flux analysis; amino acid production by Glutamic acid Bacteria	**9**
Unit 5	**Applications of Metabolic Engineering:** Pharmaceuticals and therapeutics, biosynthetic drug, personalized medicine; biofuels and bioenergy, ethanol production, algal bioenergy; Food and nutrition, nutraceuticals; Environmental applications, bioremediation, waste treatment	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Gregory N. Stepanopoulos, Aristos A. Aristidou, Jens Nielsen, MetabolicEngineeing
2.	Principles and methodologies, Academic Press, 1998.
3.	Wang D.I.C., Cooney C.L. Demain A.L. Dunnil.P., Humphery A.E. LillyM.D.

TRANSGENIC TECHNOLOGY (IBT538)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Transgenic Technology	L	T	P	
	3	1	0	Nil

Course Objective: This course provides a comprehensive overview of transgenic technology, focusing on the techniques, methods, and applications of introducing foreign genes into organisms to create transgenic plants, animals, or microbes

Course Outcomes:	
CO1	Understand the principles and methods of creating transgenic organisms.
CO2	Learn about different vectors and delivery systems for gene transfer.
CO3	Explore applications of transgenic technology in various industries.
CO4	Analyze the ethical and regulatory considerations of transgenic technology.
CO5	Conduct research and present findings on a specific topic in transgenic technology.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Biological methods of transformation:** *Agrobacterium tumefaciens* mediated transformation; Plant and animal virus mediated transformation	**9**
Unit 2	**Direct methods of transformation:** Microprojectile bombardment; Electroporation; Microinjection; Silicon carbide whiskers; Ultrasonication; Laser beam irradiation; Lipofection; Chemical methods; Chloroplast transformation; *In planta* transformation	**9**
Unit 3	**Genome editing tools:** Recombinases; Zinc finger nucleases; CRISPR/Cas 9;Transcription activator-like effector nuclease;Trap vectors	**9**
Unit 4	**Gene down-regulation and up-regulation techniques** Antisense RNA; RNA interference; dsRNA mediated DNA methylation; dsRNA mediated RNA degradation; Co-suppression; Insertional mutagenesis; T-DNA tagging; Transposon tagging; Knockouts	**9**
Unit 5	**Applications of transgenic technology:** Applications in agriculture, animal husbandry, medical, food, environmental fields;*Bt* cotton case study;Gene therapy; Purification;Surface display; Function characterization	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Principles of Gene Manipulation & Genomics by Primrose &Twyman. Seventh edition, 2006
2.	Molecular Cloning: A Laboratory Manual by J. Sambrook and David W. Russel. Third edition Publisher: Cold Spring Harbor Laboratory Press, 2001
3.	Genetic Engineering by S. Rastogi and N. Pathak. Publisher: Oxford University Press, 2009

SEMESTER III OPEN

ELECTIVE 1

HUMAN NUTRITION (OBT601)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Human Nutrition	3	1	0	Nil

Course Objective: To gain understanding on the concepts of human nutrition, including energy metabolism, and nutrient requirements and the role of carbohydrates, proteins, lipids, vitamins, and minerals in maintaining optimal health.

Course Outcomes:	
CO1	To assess the nutritional value of different foods based on their biochemical composition.
CO2	To understand the nutritional quality of carbohydrates, proteins, lipids, minerals, and vitamins in the diet.
CO3	To understand the impact of different food components on overall health and well- being.
CO4	To identify and address potential nutrient deficiencies in individuals.
CO5	To understand energy metabolism and nutrient requirements in addressing specific dietary needs and health goals.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Energy**: Energy content of different types of foods. Body composition, Physiological fuel value, Measurement of calorific value of different foods, BM, Estimating energy requirement for individuals and groups, Food groups, Balanced diet	**8**
Unit 2	**Carbohydrates:** Types, Sources, Functions, Dietary requirements and physiological significance. Glycemic index of foods. **Proteins**: Types, Sources, Functions, Dietary requirements. Evaluation methods and improvement of protein quality, Building blocks of proteins	**9**
Unit 3	**Lipids**: Types, Sources, Functions, Dietary requirements in individuals **Water:** Regulation of intra and extracellular volume, Electrolyte balance, Osmolality, Water balance and its regulation, Oral rehydration therapy	**9**
Unit 4	**Minerals**: Sources, bioavailability, functions, deficiency, interactions with other nutrients. **Macro minerals:** calcium, phosphorus, magnesium, sodium, potassium and chloride. **Micro minerals**: Iron, copper, zinc, manganese, iodine, fluoride. **Trace minerals**: selenium, cobalt, chromium.	**10**
Unit 5	**Vitamins**: Typse, Sources, Functions, Dietary requirements, Impact of deficiency of Fat soluble and Water soluble vitamins.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Bamji, M.S., Rao, N.P & Reddy, V. (1996). Textbook of Human Nutrition. Oxford & IBH Publishing Co. (P). Ltd. Delhi.
2.	Gopalan, G. RamaShastri B.V &Balasuvramnian, S.C. (2000). Nutritive Value of Indian Foods. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, 500-007, India.
3.	Sri Lakshmi, B. (2000). Nutrition Science. New Age International (P) Ltd. Pub. New Delhi
4.	Swaminathan, M. (2009). Textbook of Food and Nutrition. Bappco publishers, Bangalore.

SEMESTER 1

SKILL ENHANCEMENT COURSE 1

CELL CULTURE TECHNOLOGY

(IBT541)

Details of course: -

Course Title	Course Structure			Pre-Requisite
Cell Culture Technology	L	T	P	
	0	0	4	Nil

Course Objective: The course should provide the student with knowledge such that the student can carry out basic cell-culture techniques properly and safely, and explain factors of significance in the cultivation of cells in vitro

.

Course Outcomes:	
CO1	To understand the principles and techniques of cell culture.
CO2	To learn the different types of cell cultures and their applications.
CO3	To explore advanced applications of cell culture techniques in biotechnology and medicine.
CO4	To gain practical experience in cell culture methods and laboratory skills.
CO5	To critically analyze current research articles and developments in the field of cell culture.

CO-PO Articulation matrices: -

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**3**	**3**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S.No.	Practical's
1.	Preparation, sterilization and pouring of LB media
2.	Isolation of industrially important microorganisms for microbial process by plating, streaking and serial dilution.
3.	To study effect of temperature, pH, carbon and nitrogen sources on microbial growth.
4.	Microscopic examination of living microorganisms using a hanging-drop preparation or a wet mount.
5.	Different techniques for the sterilization of culture vessels, media, and maintenance of aseptic conditions in plant tissue culture laboratory.
6.	Preparation of different stock solutions for MS media for plant tissue culture.
7.	Establishment of cultures from shoot tips of plants by sterilizing explants with different sterilizing agents.
8.	To study different steps in the development of primary cell culture
9.	To perform trypan blue dye exclusion assay for cell viability.

References:

S.No.	Name of Book/Author/Publisher
1.	Culture of Animal Cells by R Ian Freshney
2.	Cell culture technology: Recent advances and future prospects (Euroscicon Meeting Reports Book 1) by Bruserud, Øystein and Astrid Englezou
3.	Vertebrate Cell Culture II and Enzyme Technology: Volume 39 (Advances in Biochemical Engineering/ Biotechnology) by A.F. Bückmann and G. Carrea

BIOTECHNOLOGY ENTREPRENEURSHIP & VENTURE DEVELOPMENT

(IBT543)

Details of course: -

Course Title	**Course Structure**			**Pre-Requisite**
Biotechnology Entrepreneurship & Venture Development	L	T	P	
	2	0	0	Nil

Course Objective: To understand the concepts of entrepreneurship and innovation management, identifying and evaluating opportunities in the biotechnology industry

Course Outcomes:	
CO1	To understand the importance of Entrepreneurship and Innovation in Biotechnology
CO2	To equip students with the concepts of Intellectual property rights in biotechnology (patents, trademarks, copyrights)
CO3	To impart knowledge on Biotechnology Commercialization and Financing
CO4	To understand the role of biotechnology incubators and accelerators, Accessing biotechnology-focused entrepreneurial support networks
CO5	To develop biotechnology entrepreneurial skills

CO-PO Articulation matrices: -

Course	**PO 1**	**PO 2**	**PO 3**
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**2**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**2**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

Note: Program mat add up to three additional POs approved by BOS of the department.

S. No.	Content	Contact Hours
Unit 1	**Entrepreneurship and Innovation in Biotechnology**: Fundamentals of entrepreneurship and innovation management, Identifying and evaluating opportunities in the biotechnology industry, Developing a business model for a biotechnology startup,	**6**
Unit 2	**Intellectual Property and Regulatory Aspects**: Intellectual property rights in biotechnology (patents, trademarks, copyrights), Regulatory framework and guidelines for biotechnology products and processes, Navigating the biotechnology regulatory landscape	**6**
Unit 3	**Biotechnology Commercialization and Financing**: Translating biotechnology research into commercial products, Funding sources and investment models for biotechnology startups, Developing a biotechnology business plan and pitching to investors	**6**
Unit 4	**Biotechnology Incubation and Ecosystem**: Role of biotechnology incubators and accelerators, Accessing biotechnology-focused entrepreneurial support networks, Collaborating with industry, academia, and research institutions	**6**
Unit 5	**Biotechnology Entrepreneurial Skills**: Leadership, teambuilding, and communication skills, Product development and project management, Marketing and sales strategies for biotechnology products	**6**
	Total	**30**

References:

S.No.	Name of Book/Author/Publisher
1.	Entrepreneurship in Biotechnology, Managing for Growth from Start-Up to Initial Public Offering, 2003, Martin Grossmann
2.	Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies by Craig Shimasaki, 2023
3.	Innovation and Entrepreneurship in Biotechnology, an International Perspective: Concepts, Theories and Cases ; Authors, Damian Hine, John Kapeleris, 2006
4.	Biotechnology Entrepreneurship, Leading, Managing and Commercializing Innovative Technologies, Book, Second Edition, 2020

SEMESTER II

SKILL ENHANCEMENT COURSE 2

AQUACULTURE (IBT542)

Details of course: -

Course Title	**Course Structure**			**Pre-Requisite**
	L	T	P	
Aquaculture	2	0	4	Nil

Course Objective: To give first-hand training on various aspects of Aquaculture, and to enhance quality aqua crops production

Course Outcomes:	
CO1	Gain working knowledge of aquatic organisms economically.
CO2	Acquire skills for setting up an aquarium and cultivating ornamental fishes.
CO3	Understand the role of fishes in environmental management.
CO4	Well versed in technology-based aquaculture systems like recirculating aquaculture systems
CO5	Acquire knowledge of aquaponics systems, and advances in seed production and feed Production processes.

CO-PO Articulation matrices: -

Course	**PO 1**	**PO 2**	**PO 3**
CO1	**3**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction to Aquaculture:** Designing (layout) and drawing of a self-sustainable Aquaculture farm, Identification of cultivable finfishes and shellfishes, Collection and identification of various freshwater aquatic plants, Understanding of the role of different aquatic plants in aquaculture	**8**
Unit 2	**Recirculating Aquaculture System (RAS) and water Quality management:** 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 aqua crops and their preservation.	**9**
Unit 3	**Water Quality Parameters**: Study of major water quality parameters viz., temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity and ammonia in a fish culture pond.	**9**
Unit 4	**Live Feed Culture and Feed Formulation:** 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.	**10**
Unit 5	**Aquaculture in Practice**: First hand working experience with fish in a fish farm/institute/laboratory, Preparation of a project proposal in any Area of aquaculture for financial support.	**9**
	Total	**45**

Laboratory Practical's:

1. Measurement of pH of different water samples
2. Measurement of TDS and conductivity of water samples
3. Measurement of ammonia, nitrite and nitrate of water samples
4. To measure BOD and COD for water samples
5. To visit an aquaculture site for maintenance of fish and aquatic plants

References:

S.No.	Name of Book/Author/Publisher
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 WasteWater. 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.

ARTIFICIAL INTELLIGENCE IN HEALTH CARE (IBT-544)

Details of course: -

Course Title	**Course Structure**			**Pre-Requisite**
Artificial Intelligence in healthcare	L	T	P	
	3	1	0	Nil

Course Objective: The course aims to explore the fundamental principles of AI, its practical applications in diagnostics, treatment, and patient care, and the ethical and legal considerations involved. Students will gain insight into the impact of AI on improving health outcomes, operational efficiencies, and patient engagement in the healthcare system

Course Outcomes:	
CO1	Explain the core concepts, methodologies, and technologies underpinning AI, such as Machine learning and deep learning, and their relevance in healthcare.
CO2	Identify and describe various applications of AI in medical diagnostics, treatment Planning and patient care, including predictive analytics and personalized medicine.
CO3	Demonstrate the ability to use specific AI tools and software for data analysis in Healthcare settings, simulating diagnostic processes and patient management systems.
CO4	Critically analyze the ethical, privacy, and legal implications of using AI in healthcare, Including data security and the impact on patient-provider relationships.
CO5	Assess and forecast emerging trends and innovations in AI that could further transform The healthcare industry.

CO-PO Articulation matrices: -

Course	**PO 1**	**PO 2**	**PO 3**
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**2**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction to AI in Healthcare:** Definitions, history, and evolution of AI technologies, Machine learning, deep learning, neural networks, and natural language processing in the context of healthcare.	**8**
Unit 2	**AI Applications in Medical Diagnostics:** Imaging and Radiology: AI applications in analyzing medical images, including X-rays, CT scans, and MRIs; Pathology: Use of AI in detecting and diagnosing diseases from pathological samples; Predictive Analytics: Leveraging AI for predicting disease outbreaks, patient outcomes, and prognosis.	**9**
Unit 3	**AI in Treatment Planning and Management:** Personalized Medicine, Robotics and Surgical Aids, Drug Development-AI's role in accelerating drug discovery and validation processes.	**9**
Unit 4	**AI in Patient Care and Management:** Virtual Health Assistants: Deployment of AI-powered chatbots and virtual assistants for patient engagement and management, Remote Monitoring: AI tools for monitoring patient vitals and conditions remotely; Healthcare Bots	**10**
Unit 5	**Ethical, Legal, and Social Implications of AI in Healthcare:** Ethical Considerations, Privacy and Security, Future Trends and Innovations, Exploring emerging AI technologies and their potential future impact on healthcare.	**9**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	"Artificial Intelligence in Healthcare" by Adam Bohr and Kaveh Memarzadeh.
2.	“Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again" by Eric Topol.
3.	"AI in Health: A Leader’s Guide to Winning in the New Age of Intelligent Health Systems" by Tom Lawry