DEPARTMENT OF BIOTECHNOLOGY
DELHI TECHNOLOGICAL UNIVERSITY:
DELHI
Established under Govt. of Delhi Act 6 of 2009
Shahbad Daulatpur, Bawana Road, Delhi-110042

M.Tech (IBT) syllabus

SEMESTER I							
COURSE CODE	**TYPE**	**SUBJECT**	**CREDIT**	**L**	**T**	**P**	**TOTAL CREDIT**
IBT501	Core	Bioenergy	4	3	0	2	24
IBT505	Core	Industrial Plant Biotechnology	4	3	0	2	
IBT507	Core	Enzyme technology & Industrial Application	4	3	0	2	
IBT509	Core	Functional Genomics & Proteomics	4	3	0	2	
IBT531	**DEC**	**Department Elective 1**					
IBT5311	DEC	Industrial waste water treatment	4	3	1	0	
IBT5312	DEC	Nutraceuticals and Functional Foods	4	3	1	0	
IBT5313	DEC	Cell and Molecular Biology	4	3	0	2	
IBT5314	DEC	Recombinant DNA Technology	4	3	1	0	
IBT5315	DEC	Biopharmaceuticals	4	3	1	0	
IBT5315	DEC	Bioinformatics	4	3	0	2	

IBT525	Self Study		2	2	0	0	
IBT523	**SEC**	**Skill enhancement Course -1**					
IBT5231	SEC	Cell Culture Technology	2	0	0	4	
IBT5232	SEC	Biotechnology Entrepreneurship & Venture Development	2	2	0	0	
UEC501	Audit Course		0	0	0	0	

SEMESTER II

COURSE CODE	TYPE	SUBJECT	CREDIT	L	T	P	TOTAL CREDIT
IBT502	Core	Advanced Environmental Biotechnology	4	3	0	2	24
IBT504	Core	Biosafety, Bioethics & IPR	4	3	1	0	
IBT532	**DEC**	**Departmental Elective 2**					
IBT5321	DEC	Industrial Microbiology and Fermentation Technology	4	3	1	0	
IBT5322	DEC	Food Engineering & Biotechnology	4	3	1	0	
IBT5323	DEC	Biopolymer Technology	4	3	1	0	
IBT5324	DEC	Plant Molecular Pharming	4	3	1	0	
IBT5325	DEC	Nanobiotechnology	4	3	1	0	
IBT534	**DEC**	**Departmental Elective 3**					
IBT5341	DEC	Biosensor Technology	4	3	1	0	
IBT5342	DEC	Bioinstrumentation	4	3	1	0	
IBT5343	DEC	Vaccine Technology	4	3	1	0	
IBT5344	DEC	Metabolic Engineering	4	3	1	0	
IBT5345	DEC	Transgenic Technology	4	3	1	0	
UCC502	Research methodology		4	3	1	0	
IBT546/ IBT548	**SEC**	**Skill Enhancement Course 2/Industrial Training**					
IBT5461	SEC	1.Aquaculture	4	2	0	4	
IBT5462	SEC	2.AI in Health care	4	3	1	0	

SEMESTER III							
COURSE CODE	**TYPE**	**SUBJECT**	**CREDIT**	**L**	**T**	**P**	**TOTAL CREDIT**
IBT601	Core	Bioprocess Engineering & Reactor designing	4	3	0	2	
UEC601	**Open Elective 1**						
UEC6011		.Human Nutrition	4	3	1	0	
UEC6012		Algal Biotechnology	4	3	1	0	16
UEC6013		Green Energy	4	3	1	0	
UEC6014		Sustainable Agriculture	4	3	1	0	
UEC6015		Food Biochemistry	4	3	0	2	
IBT603	Minor Project/Research Thesis/Patent		8	0	0	8	

SEMESTER IV							
COURSE CODE	**TYPE**	**SUBJECT**	**CREDIT**	**L**	**T**	**P**	**TOTAL CREDIT**
IBT602	Minor Project/Research Theisis/Patent		8	0	0	16	16

M.Tech (IBT) syllabus (DEPARTMENT CORE COURSES)

FIRST YEAR (Semester 1)

BIOENERGY (IBT-501)

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 biohydrogen and biodiesel

Course Outcomes:	
1.	To gain understanding on the global energy scenario, and biofuel production
2.	To understand the concepts of bio-ethanol production
3.	To impart knowledge on the production of biohydrogen by agricultural residues
4.	To gain understanding on the concepts of biodiesel production
5.	To understand the concepts of applied bioenergy with reference to Indian context

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 biohydrogen production.

Books :

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) - Biohydrogen
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
(IBT-505)

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:	
1.	Understanding the basic principles of plant tissue culture and techniques
2.	Knowledge of production means and mass cultivation using tissue culturing
3.	Imparting Knowledge about various techniques used for genetic modifications in plants
4.	Knowledge of applicability of transgenics in solving various issues faced by humanity
5.	Learning of regulatory issues and ethical concerns involved in plant genetic engineering

S. No.	**Content**	**Contact Hours**
Unit 1	**Introduction to Plant Tissue Culture:** Cellular totipotency, Micropropagation; Types of culture, Seed culture, embryo culture, Protoplast culture, Cell suspension; Invitro production of haploids; Somaclonal 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 vectorless gene transfer; Agrobacterium mediated DNA transformation; status and expression of transferred genes.	**9**

Unit 4	**Transgenics in Crop Improvement:** Resistance to biotic stresses and abiotic stresses; Herbicide resistance; Transgenics for quality, Transgenics 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**

Books :

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 micropropagation
- Introduction to plant specific databases

ENZYME TECHNOLOGY AND INDUSTRIAL APPLICATION

(IBT-507)

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.

Course Outcomes:	
1.	Understand the concept of Enzyme, nomenclature and its classification.
2.	Illustrate the kinetics and mechanism of Enzyme.
3.	Compare and contrast the types of Enzyme Immobilization.
4.	Identify the Enzyme Reactor for Batch/ continuous enzymatic processing.
5.	Understand the application of enzymes.

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.

Books :

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 (IBT-509)

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

S. No.	Content	Contact Hours
Unit 1	**Tools in Genomics and Genome Editing:** Next Generation Sequencing techniques; Genome sequencing; DNA fingerprinting; Crispr-Cas9, ZFN, TALEN	**8**
Unit 2	**Transcriptomics & 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	**Interactomics:** Methods for detecting DNA-protein interactions: Chromatin immunoprecipitation assay, Gel retardation assay, DNase I footprinting, Modification interference assay, DNA pull-down assay, Microplate capture and detection assay, Reporter assays; Methods for detecting protein-protein interactions: Coimmunoprecipitation, Yeast two-hybrid system and variants, Phage display, GFP tagging, Intein splicing; TAP tagging; Protein chips; Synthetic lethal screens; Yeast genome-wide interaction studies	**10**
Unit 5	**Pharmacogenomics and Personalized Medicine:** Single nucleotide polymorphism; Principle of pharmacogenomics; Case studies for personalized medicine	**9**
	Total	**45**

Books :

	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

Practicals:

- 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

FIRST YEAR (Semester 2)

ADVANCED ENVIRONMENTAL BIOTECHNOLOGY (IBT-502)

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:	
1.	To provide conservation knowledge and understanding on the concepts of environmental conservation
2	To gain understanding on different types, sources and effects of environmental pollution
3	To gain understanding on the concepts of bioremediation with focus on in-situ and ex-situ conservation
4	To impart knowledge on the understanding of solid waste management and its treatment strategies
5	To study effects of effluent and its treatment strategies

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.

Books :

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 (IBT-504)

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:	
1.	Understanding the significance of intellectual property and biosafety principles.
2	Mastering the concept of & "prior art and proficiently conducting patent searches.
3	Gaining knowledge of patent basics and procedures for effective patent filing.
4	Developing practical skills in patent filing and understanding patent infringement.
5	Comprehending biosafety principles and regulations governing production and use of GMO release.

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**

Books :

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

RESEARCH METHODOLOGY (UCC-502)

Details of course: -

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

Course Objective: A research methodology gives research legitimacy and provides scientifically sound findings and helps to keep researchers on track, making the process smooth, effective and manageable

Course Outcomes:	
1.	Understand the steps involved in identification and formulation of research problem.
2	Acquire knowledge about research design and sampling techniques.
3	Illustrate and interpret data Scientific writing.
4	Understand the Formulation of scientific communication.
5	Interpret results of commonly used statistical analyses using computer application.

S. No.	Content	Contact Hours
Unit 1	An overview of research methodology: Research concept, steps involved, identification, selection and formulation of research problem, justification, hypothesis; literature collection-textual and digital resources (internet)	**8**
Unit 2	Research design, data collection and interpretation: Research design; sampling techniques, presentation, analysis.	**9**
Unit 3	Interpretation of data Scientific writing: Forms of scientific writing- Article, notes, reports, review article, monographs, dissertations, popular science articles, bibliographies.	**9**
Unit 4	Formulation of scientific communication - Outline preparation, drafting title, sub titles, tables, illustrations; Formatting tables- title, body footnotes; figures & graphs- structure, title and legends, Impact factor, citation indices, plagiarism	**10**
Unit 5	Computer application: MS office, excel, power point, graphics (Sigma plot), statistical software ESPSS)	**9**
	Total	**45**

Books :

S.No.	Name of Book/Author/Publisher
1	Research Methodology - Methods & Techniques, CR Kothri CR (1990), Vishva Prakashan, New Delhi.
2	Research methodology for biological sciences, N Gurumani (2007), MJP Publishers, Chennai.
3	Introduction to Biostatistics, L Forthofer (1995), Academic Press, New York.
4	Experimental Design & Data Analysis for Biologists. PQ Gerry & JK Michael (2002), Cambridge University Press.

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:	
1	Understand the basics of media design and sterilization kinetics.
2	Summarize the metabolic stoichiometry and microbial Growth kinetics.
3	Compare and contrast the type and design of bioreactor.
4	To gain knowledge about Instrumentation and its control.
5	To gain insight to the working of downstream processes at an industrial scale.

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	**10**
	optimization of microbiological processes.	

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 dinitrosalicylic 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 .

Books :

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 (IBT531)

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INDUSTRIAL WASTEWATER TREATMENT (IBT5311)

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:	
1	To impart knowledge on the sources of solid waste, industrial waste effluents
2	To gain understanding on different characteristics of waste and toxic byproducts formed
3	To study small and large scale remediation of industrial waste
4	To gain understanding on different microbes used for wastewater remediation
5	To learn about the advanced treatment technologies for industrial wastewater treatment

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,	**9**

	Selective membrane.	
	Total	**45**

Books :

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.

NUTRACEUTICALS AND FUNCTIONAL FOODS (IBT5312)

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Nutraceuticals and Functional Foods	3	1	0	Nil

Course Objective: This course explores the science and technology of nutraceuticals and functional foods. Students will study the sources, properties, health benefits, and applications of bioactive compounds in foods

Course Outcomes:	
1	Understand the concepts of nutraceuticals and functional foods
2	Learn about the sources and properties of bioactive compounds in foods
3	Explore the health benefits and applications of functional foods and nutraceuticals
4	Gain knowledge of the regulatory framework and market trends
5	Develop skills in formulating and developing functional food products

S. No.	Content	Contact Hours
Unit 1	**Introduction to Nutraceuticals as Science:** Historical perspective; classification; scope & future prospects; Applied aspects of the Nutraceutical Science; Sources of Nutraceuticals; Relation of Nutraceutical Science with other Sciences: Medicine, Human physiology, genetics, food technology, chemistry and nutrition.	**9**
Unit 2	**Phytonutraceuticals:** Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine, alphaKetoglutarate. Use of proanthocyanidins, grape products, flaxseed oil as Nutraceuticals.	**9**
Unit 3	**Food as remedies:** Nutraceuticals bridging the gap between food and drug, Treatment for cognitive decline, common disorders like Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers; Brief idea about some Nutraceutical rich supplements, Caffeine, Green tea, Lecithin, Mushroom extract, Chlorophyll, Kelp and Spirulina	**9**

Unit 4	**Functional Foods I:** Definition, Relation of functional foods & Nutraceutical (FFN) to foods & drugs. Applications of herbs to functional foods.Concept of free radicals and antioxidants; Nutritive and Non-nutritive food components with potential health effects. Effect of processing on Nutrients. Soy proteins andsoy isoflavones in human health; Role of nuts in cardiovascular disease prevention. Functional foods from wheat and rice and their health effects.	**9**
Unit 5	**Functional Foods II:** Sources and role of Isoprenoids, Isoflavones, Flavonoids, carotenoids, Tocotrienols, polyunsaturated fatty acids, sphingolipids, lecithin, choline.terpenoids. Vegetables, Cereals, milk and dairy products as Functional foods; Health effects of common beans, Capsicum, mustards, Ginseng, garlic, grape, citrus fruits	**9**
	Total	**45**

Books :

S.No.	**Name of Book/Author/Publisher**
1.	Aluko, Rotimi, Functional Foods and Nutraceuticals, Springer-Verlag New York Inc.,2012.
2.	Satinder Kaur Brar, Surinder Kaur and Gurpreet Singh Dhillon, Nutraceuticals Functional Foods,2014.
3.	Robert E.C. Wildman, Robert,Wildman, Taylor C, Handbook of Nutraceuticals and Functional Foods, Third Edition,Wallace, 2002

CELL & MOLECULAR BIOLOGY (IBT5313)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Cell & Molecular Biology	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:	
1	To learn the mechanisms of biological processes involved in gene expression
2	To explain the concept of cell cycle and cell division and the impact of excessive cell proliferation
3	To comprehend mechanisms of cellular signaling and protein targeting within the cell or to the cell exterior
4	To gain insight into the strategies for gene silencing
5	To appraise various Cell & Molecular Biology techniques

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**

Books :

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

Practicals

- 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
(IBT5314)

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:	
1	Understand the fundamental concepts of recombinant DNA technology
2	Learn Key techniques for gene cloning, expression and editing
3	Explore the applications of recombinant DNA technology in various fields
4	Analyze the ethical and regulatory considerations in recombinant DNA research
5	Conduct research and present findings on a specific topic in recombinant DNA technology

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**

Books :

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

BIOPHARMACEUTICALS (IBT5315)

Details of course:-

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

Course Objective: This course provides a comprehensive overview of biopharmaceuticals, focusing on the scientific principles, development, production, and application of pharmaceutical products derived from biological sources.

Course Outcomes:	
1	Understand the principles of biopharmaceuticals and their development.
2	Learn about drug discovery and production processes.
3	Explore applications of biopharmaceuticals in medicine and other fields
4	Analyze the regulatory and quality control aspects of biopharmaceuticals.
5	Conduct research and present findings on a specific topic in biopharmaceuticals.

S. No.	Content	Contact Hours
Unit 1	**Introduction:** Pharmaceutical Industry & Development of Drugs; Types of Therapeutic Agents and Their Uses; Economics and Regulatory Aspects.	**9**
Unit 2	**Drug Action, Metabolism And Pharmacokinetics**: Mechanism Of Drug Action; Physico-Chemical Principles Of Drug Metabolism; Radioactivity; Pharmacokinetics.	**9**
Unit 3	**Manufacture Of Drugs, Process And Applications** : Types of Reaction, Process And Special Requirements For Bulk Drug Manufacture.	**9**
Unit 4	**Principles of Drug Manufacture:** Compressed Tablets; Dry And Wet Granulation; Slugging Or Direct Compression; Tablet Presses; Coating of Tablets; Capsule Preparation; Oval Liquids; Vegetable Drugs; Topical Applications; Preservation Of Drugs; Analytical Methods And Other Tests Used In Drug Manufacture; Packing Techniques; Quality Management; GMP.	**9**
Unit 5	**Drug safety evaluation:** Strategy and Phasing for Drug Safety, Acute Toxicity Testing in Drug Safety Evaluation, Special Concerns for the Preclinical Evaluation of Biotechnology Products.	**9**
	Total	**45**

Books :

S.No.	Name of Book/Author/Publisher
1.	Heinrich Klefenz , Industrial pharmaceutical biotechnology, John Wiley sons, 2002.
2.	Susanna Wu-Pong, YongyutRojanasakul, and Joseph Robinson, Biopharmaceutical drug and design and development, Humana Press, 2007.
3.	Gary Walsh, Biopharmaceuticals: Biochemistry and Biotechnology (2e), John Wiley & Sons, 2003

BIOINFORMATICS (IBT5316)

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:	
1	Identify and utilize various biological databases; understand database types, sequence formats, retrieval methods, and submission protocols.
2	Understand the basics of genomics, including the significance of the Human Genome Project.
3	Develop and execute programming skills necessary for bioinformatics.
4	Conduct Pairwise Sequence Alignment using appropriate scoring matrices and understand underlying algorithms.
5	Execute Multiple Sequence Alignment and understand the associated algorithms.

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**

Practicals:

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.

Books :

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

SEMESTER II

ELECTIVE 2 (IBT532)

INDUSTRIAL MICROBIOLOGY AND FERMENTATION TECHNOLOGY (IBT5321)

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:	
1	Understand the basics of Inoculum Development and Media Preparation
2	Compare and contrast Process technology for Primary and Secondary metabolites
3	Summarize the Sterilization and Cell growth kinetics
4	To gain insight of the Fermentation Process
5	Understand the design of Fermenter and its control

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**

Books :

S.No.	**Name of Book/Author/Publisher**
1.	Presott& Dunn's Industrial Microbiology. Ed. E.G. Reed (1987). CBS Publishers, NewDelhi.
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 (IBT5322)

Details of course: -

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

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

Course Outcomes:

1	To gain knowledge on the concepts of food chemistry and nutrition
2	To impart understanding on the macromolecules involved in human nutrition
3	To study different fermentation products involved in food
4	To gain understanding on the concepts of food storage and packaging
5	To understand the concepts of food standard quality parameters and techniques

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**

Books :

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. Conneticut 1983
4.	B.Sivashankar – Food processing and preservation, Prentice – Hall of India Pvt.Ltd.New Delhi 2002

BIOPOLYMER TECHNOLOGY (IBT5323)

Details of course: -

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

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

Course Outcomes:	
1	**Understand the about Biopolymers, types, characteristics**
2	List the applications of Biopolymers
3	Illustrate the source characteristics of Biosurfactants
4	Gain insight of Bioplatics and its synthesis
5	Demonstrate the material testing and analytical methods

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 (Vinylalcohol) 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	**Biosurfactants** Source, characteristics and properties of Biosurfactants; Production of Biosurfactants via the fermentation and biotransformation routes; Production of Biosurfactants with immobilized cells; Integrated bioprocess for continuous production of Biosurfactants including downstream processing; Applications of Biosurfactants-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**

Books :

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
(IBT5324)

Details of course:-

Course Title	**Course Structure**			**Pre-Requisite**
	L	T	P	
Plant Molecular Pharming	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:	
1	Understand the principles of plant molecular farming.
2	Learn about the genetic engineering of plants for pharmaceutical production.
3	Explore applications of plant molecular farming in medicine and industry
4	Analyze the ethical and regulatory considerations in plant molecular farming
5	Conduct research and present findings on a specific topic in plant molecular farming

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**

Books :

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, Books and Allied (P) Ltd. (2005)

NANOBIOTECHNOLOGY (IBT5325)

Details of course:-

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

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

Course Outcomes:	
1.	Understand the basics concepts of nanosciences and its applications.
2	Illustrate the synthesis process and mechanism of nanomaterials.
3	Applications of different types of nanomaterials and its compositions.
4	Illustrate the applications of Nanobiotechnology.
5	Understanding the toxicological effects of nanomaterials and its management.

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. Nanopores, carbon nanotubes Applications of NanoMolecules in Biosystems.	**9**
Unit 3	**Structural and functional principles of nanobiotechnology**-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 Bionanotechnology: Information driven nanoassembly, Energetics, Bimolecular motors: ATP Synthetase and flagellar motors.	**9**
Unit 4	**Application of Nanobiotechnology**-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	**Nanotoxicology:** 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**

Books :

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.

SEMESTER -2

ELECTIVE 3 (IBT534)

BIOSENSOR TECHNOLOGY (IBT5341)

Details of course:-

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

Course Objective: The objective of this course is to impart education in Biosensing technology, their working, applications and future perspective.

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

S. No.	Content	Contact Hours
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. Bioelectronic device production: microelectronic fabrication methods as adapted to bioelectronics, hard and soft lithography, bio-compatibility of materials. Existing types of Biosensors: Miniaturisation 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**

Books :

S.No.	Name of Book/Author/Publisher
1.	Rajmohan Joshi, Biosensors (1e), Gyan Books, 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 (IBT5342)

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Bioinstrumentation	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:	
1	Discuss the principle of centrifugation and its types.
2	List uses of electrophoretic techniques underlying electrophoresis systems.
3	Discuss chromatographic methods.
4	Explain spectroscopic and diffraction techniques.
5	Define optical techniques like microscopy.

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**

Books :

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.

VACCINE TECHNOLOGY (IBT-5343)

Details of course: -

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

Course Objective: The course objective is to provide students with a comprehensive understanding of vaccine development, immunization principles, and immune response mechanisms.

Course Outcomes:	
1	Understanding how antigens and antibodies interact, and the mechanisms of immune re ponses.
2	Gaining comprehensive knowledge of cellular and humoral immunity for development of effective vaccine strategies
3	Classifying different vaccine types and assessing their suitability for various diseases and populations.
4	To comprehend vaccine formulation components, manufacturing processes, and quality control measures.
5	Exploring the phases of clinical trials, the regulatory processes for safe vaccine development.

S. No.	Content	Contact Hours
Unit 1	**Antigen-Antibody Interaction & Immune Response** Interaction between antigens and antibodies, immune responses such as neutralization and cell-mediated cytotoxicity	**8**
Unit 2	**Principle for vaccination**Acquired immunity, Active and passive immunization, T cell and B cell immune responses, importance of booster doses	**9**
Unit 3	**Vaccine Type** Types of vaccines, Live attenuated, inactivated, toxoid, subunit, conjugated, recombinant, DNA, and edible vaccines Synthetic vaccines; Polyvalent vaccines; Monoclonal, vaccines, Vaccines against bacterial diseases	**9**
Unit 4	**Vaccine Formulation & Manufacturing** Formulation of vaccines, egg based and cell based vaccine, improving vaccine efficacy includes adjuvants, stabilizers, preservatives, and antibiotics for stability and efficacy. Manufacturing involves antigen purification and quality control.	**10**
Unit 5	**Clinical Trials & Regulation** Clinical trials evaluate safety and efficacy, with regulatory bodies overseeing approval based on data and manufacturing standards.	**9**

	Total	**45**

Books :

S.No.	Name of Book/Author/Publisher
1.	Roitt's Essential Immunology byPeter J Delves; Seamus J Martin; Dennis R Burton; Ivan M Roitt. Publisher: John Wiley & Sons, Inc., 13 th Edition, 2017
2.	The Vaccine Book: Making the Right Decision for Your Child by Robert W. Sears. Publisher: Little, Brown and Company, 1 st edition, 2007
3.	Vaccines: What Everyone Needs to Knowby Kristen A. Feemster. Publisher: Oxford University Press, 1st edition, 2017

METABOLIC ENGINEERING (IBT5344)

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Metabolic Engineering	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:	
1	Understand the principles and techniques of metabolic engineering.
2	Learn about metabolic pathways and their regulation
3	Explore applications of metabolic engineering in various industries.
4	Analyze the ethical and regulatory considerations in metabolic engineering
5	Conduct research and present findings on a specific topic in metabolic engineering.

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 -reaction rates-dynamic mass balances-Yieldcoefficients and linear rate equation; Material Balance and data consistency –blackbox 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**

Books :

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 (IBT5345)

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Transgenic Technology	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:	
1	Understand the principles and methods of creating transgenic organisms.
2	Learn about different vectors and delivery systems for gene transfer.
3	Explore applications of transgenic technology in various industries.
4	Analyze the ethical and regulatory considerations of transgenic technology.
5	Conduct research and present findings on a specific topic in transgenic technology.

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**

Books :

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

(UEC601)

HUMAN NUTRITION (UEC6011)

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

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**

Books :

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.

ALGAL BIOTECHNOLOGY (UEC6012)

Details of course:-

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

Course Objective: The course emphasizes the biology and diversity of algae, their cultivation and processing, and their applications in various industries such as biofuels, food, pharmaceuticals, and environmental management.

Course Outcomes:	
1	Understand the diversity and biology of algae
2	Learn about algal cultivation techniques and production systems
3	Explore the applications of algae in various industries
4	Analyze the potential of algae for sustainable biotechnological applications
5	Conduct research and present findings on a specific topic in algal biotechnology

S. No.	Content	Contact Hours
Unit 1	**Introduction to algae:** Habitat; Classification of algae; Body organization; Cell Structure; Metabolism-Nutrition & respiration; Reproduction; Life cycle	**9**
Unit 2	**Algae isolation techniques:** Basic culturing and analytical measurement techniques; Cultivation methods-Ponds and photobioreactors; Design of cultivation vessels; Harvest techniques; Drying techniques; Cell disruption techniques	**9**
Unit 3	**Biomolecules extraction techniques:** Lipid, Protein, Carbohydrate; Organic Solvents for biomolecules extraction; High value chemicals from algae; Algal Biorefinery.	**9**
Unit 4	**Algal biofuels:** Challenges and prospects; Algal biofuels production techniques-Biodiesel, Bioethanol, Biogas &Biohydrogen; Market of algal biofuels and other products- Indian & Global scenario; India Biofuels Policy.	**9**
Unit 5	**Bioremediation by algae:** Heavy metal removal and nutrient recovery; Commercial algal species of industrial production-*Chlorella, Spirulina, Dunaliella, Hematococcus, Chlamydomonas.*	**9**
	Total	**45**

Books :

S.No.	Name of Book/Author/Publisher
1.	Handbook of Microalgal Culture: Applied Phycology and Biotechnology. Edited by Amos Richmond and Qiang Hu. -Second edition.
2.	The structure and production of algae. Vol-I & II. By F E Fritsch.
3.	Biofuels Engineering Process Technology by Drapchoetal.McGraw Hill Publication 2008.

GREEN ENERGY (UEC6013)

Details of course:-

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

Course Objective: Green Technology subject will enhance the knowledge and describe the production of knowledge-based products or provide services that improve operational performance, productivity, or efficiency, while reducing costs, inputs, energy consumption, waste, and pollution.

Course Outcomes:	
1	To equip students with multi-disciplinary skills and knowledge in the areas of green energy generation and green processes
2	To impart knowledge on energy, environment, chemistry, management, and other GET-related fields.
3	To provide understanding on various energy conversion technologies and methods to generate energy from different sources.
4	To impart knowledge on different forms of energy used and their sustainability.
5	To equip students with recent technologies for green energy advancements and challenges

S. No.	Content	Contact Hours
Unit 1	**Energy, Environment, renewable energy, and sustainable development**: Understanding sustainable development goals, fundamentals of energy and environment, renewable energy, sustainable development, energy scenario at the national and global level.	**8**
Unit 2	**Solar Thermal Technology & Energy Conversion Systems:** Solar thermal energy conversion processes, storage and the utilization of solar thermal energy.	**9**
Unit 3	**Wind/Ocean/Tidal Energy Technology/ Small Hydropower Systems**: Source of energy, its characterization and various methods of harnessing the same, energy generation from hydropower, energy from ocean waves	**9**
Unit 4	**Bio-energy and conversion systems:** Energy from waste, microalgal biomass culture, biodiesel generation, bioprospecting of lignocellulosic resource for bio-energy, biofuel generations	**10**
Unit 5	**Energy and Economy:** Gross domestic product (GDP) and energy market, energy efficiency, environmental sustainability index and global measure	**9**
	Total	**45**

Books :

S.No.	Name of Book/Author/Publisher
1.	Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000
2.	Energy and the Environment, Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A., 2nd Edition, John Wiley, 2006
3.	Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, Jean- Philippe; Zaccour, Georges (Eds.), 2005.

SUSTAINABLE AGRICULTURE (UEC6014)

Details of course:-

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

Course Objective: To gain understanding on the concepts of diverse aspects of agriculture and agricultural sustainability, how agriculture uses resources, and various questions that raise about the sustainability

Course Outcomes:	
1	Gain a deep understanding of sustainable agriculture principles, including soil health, water management, biodiversity conservation, integrated pest management
2	Learn to optimize the use of natural resources such as water, soil, and energy
3	Reducing waste and minimizing environmental degradation associated with conventional farming methods
4	Focus on enhancing soil fertility, structure, biodiversity, leading to improved soil health and long-term productivity
5	Understanding the significance of soil health in sustainable agriculture

S. No.	Content	Contact Hours
Unit 1	**Introduction to Sustainable agriculture**: Overview of sustainable agriculture principles and frameworks, Current trends in sustainable agriculture, the role of agriculture in environmental degradation and climate change	**8**
Unit 2	**Importance of soil health in sustainable agriculture**: Soil conservation techniques: erosion control, cover cropping, Soil fertility enhancement: composting, green manures, and organic amendments	**9**
Unit 3	**Efficient water use in agriculture**: Drip irrigation, rainwater harvesting, water recycling, Sustainable drainage systems and wetland restoration, addressing water scarcity and drought resilience in agricultural systems	**9**
Unit 4	**Application of various techniques:** Benefits of crop rotation, designing crop diversification plans for pest and disease management, integration of legumes in nitrogen-fixing plants	**10**
Unit 5	**Case Studies**: Examples of agricultural sustainability with reference to practices being followed and future trends	**9**
	Total	**45**

Books :

S.No.	Name of Book/Author/Publisher
1.	Introduction to Sustainable Agriculture" by C.A. Francis
2.	Principles of Sustainable Soil Management in Agroecosystems" by Rattan Lal
3.	Integrated Pest Management: Principles and Practice" by Dharam P. Abrol and Uma Shankar
4.	Sustainable Agriculture: Advances in Plant Metabolome and Microbiome 1st Edition - November 20, 2019 , Authors: Javid Ahmad Parray, Nowsheen Shameem

FOOD BIOCHEMISTRY (UEC6015)

Details of course:-

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

Course Outcomes:	
1	To understand the concept of nutrition, measurement of calorific value of foods
2	To impart knowledge on the carbohydrates intake, dietary fiber, role of fiber in lipid metabolism
3	To review the classification, sources, functions, digestion, absorption, utilization and storage of essential Fatty Acids
4	To understand and review the functions of proteins in the body, Digestion and absorption
5	To learn the classification of Vitamin A, D, E, K Dietary sources, RDA, Adsorption, Distribution, (ADME), Deficiency.

Course Objective: To understand the concepts of food biochemistry, nutrition, metabolism, and dietary macromolecules and micromolecules

S. No.	Content	Contact Hours
Unit 1	**Introduction to Nutrition and Energy Metabolism:** Defining Nutrition, role of nutrients. Unit of energy, Physiological energy value of foods. Measurement of calorific value of foods. Physical activity, factors affecting energy input - hunger, appetite, energy balance. Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.	**8**
Unit 2	**Dietary carbohydrates and health**: Review functions of carbohydrates. Digestion, absorption, utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates,	**9**
Unit 3	**Dietary lipid and health:** Review of classification, sources, functions, digestion, absorption, utilization and storage. Essential Fatty Acids; Functions of EFA. Role of saturated fat, cholesterol, lipoprotein and triglycerides. Importance of the following: a) Omega – fatty acids. Omega 3/ omega 6 ratio b) Phospholipids c) Cholesterol in the body d) Mono, Polyunsaturated and Saturated Fatty Acids.	**9**
Unit 4	**Dietary Proteins and health:** Review of functions of proteins in the body, Digestion and absorption. Essential and Nonessential amino acids. Effects of deficiency. Food sources and Recommended Dietary Allowances for different age groups. Amino acid pool.	**10**

Unit 5	**Fat and water soluble Vitamins:** Vitamin A, D, E, K Dietary sources, RDA, Adsorption, Distribution, (ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Vitamin C- role as cofactor in amino acid modifications.Vitamin B6-Dietary source. Vitamin B12 and folate; Dietary source, Assessment of nutritional status.	**9**
	Total	**45**

Laboratory Practicals:

1. To estimate biochemical composition of proteins, fats and carbohydrates
2. To estimate the protein content in a sample by Kjeldahl method
3. To estimate the vitamins in a sample by HPLC
4. To estimate the content of fatty acids by Gas Chromatography
5. Quantification of amino acids using Amino Acid Analyzer

Books :

S.No.	Name of Book/Author/Publisher
1.	Principles of Biochemistry- A.Lehninger , CBS Publishers and Distributors , 1987.
2.	Zubay. Biochemistry. 4th ed. William C. Brown Publication, 1998.
3.	Walter. Molecular biology of the Cell. 4th ed. Garland publishing Inc, 2002.
4.	Prateek Kumar, Nutrition And Food Hygiene, Orange books international, 2017
5.	Dr. M Swaminathan , Advanced Text Book On Food & Nutrition - Volume 2 , THE BANGALORE PRESS, 2nd edition, 2015

SEMESTER 1

SKILL ENHANCEMENT COURSE 1 (IBT523)

CELL CULTURE TECHNOLOGY (IBT5231)

Details of course:-

Course Title	**Course Structure**			**Pre-Requisite**
	L	T	P	
Cell Culture Technology	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:	
1	To understand the principles and techniques of cell culture.
2	To learn the different types of cell cultures and their applications.
3	To explore advanced applications of cell culture techniques in biotechnology and medicine.
4	To gain practical experience in cell culture methods and laboratory skills.
5	To critically analyze current research articles and developments in the field of cell culture.

CELL CULTURE TECHNOLOGY LAB:

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.

Books :

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 (IBT5232)

Details of course:-

Course Title	**Course Structure**			**Pre-Requisite**
	L	T	P	
Biotechnology Entrepreneurship & Venture Development	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:	
1	To understand the importance of Entrepreneurship and Innovation in Biotechnology
2	To equip students with the concepts of Intellectual property rights in biotechnology (patents, trademarks, copyrights)
3	To impart knowledge on Biotechnology Commercialization and Financing
4	To understand the role of biotechnology incubators and accelerators, Accessing biotechnology-focused entrepreneurial support networks
5	To develop biotechnology entrepreneurial skills

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**

Books :

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 /INDUSTRIAL TRAINING

IBT548/IBT546

AQUACULTURE (IBT5461)

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 aquacrops production

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

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 aquacrops 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 Practicals:

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

Books :

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-5462)

Details of course:-

Course Title	**Course Structure**			**Pre-Requisite**
	L	T	P	
Artificial Intelligence in healthcare	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:	
1	Explain the core concepts, methodologies, and technologies underpinning AI, such as machine learning and deep learning, and their relevance in healthcare.
2	Identify and describe various applications of AI in medical diagnostics, treatment planning, and patient care, including predictive analytics and personalized medicine.
3	Demonstrate the ability to use specific AI tools and software for data analysis in healthcare settings, simulating diagnostic processes and patient management systems.
4	Critically analyze the ethical, privacy, and legal implications of using AI in healthcare, including data security and the impact on patient-provider relationships.
5	Assess and forecast emerging trends and innovations in AI that could further transform the healthcare industry.

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**

Books :

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.