Department of Biotechnology & Bioinformatics

Minor Programme and Proficiencies in Biotechnology & Bioinformatics

To consider the approval of offering following Minor areas of 20 Credits each in Biotechnology and Bioinformatics: Minor in Biotechnology & Minor in Bioinformatics

Minor in Biotechnology

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11BT312	Biochemistry	3	0	0	**3**	**3**
2	Professional Core	18B17BT372	Biochemistry Lab	0	0	2	**1**	**2**
3	Professional Core	18B11BT411	Cell Biology & Cell Culture Technology	3	1	0	**4**	**4**
4	Professional Core	18B17BT471	Cell Biology & Cell Culture Technology Lab	0	0	2	**1**	**2**
5	Engg Science	18B11BT513	Immunology *	3	1	0	**4**	**4**
6	Engg Science	18B17BT573	Immunology Lab**	0	0	2	**1**	**2**
7	Professional Core	18B11BT611	Downstream Processing	3	0	0	**3**	**3**
8	Professional Elective	18B1WBT731	Industrial Enzymes Technologies	3	0	0	**3**	**3**
						Total	**20**	**23**
	Credit breakup: Semester — Credits 3rd — 4 4th — 5 5th — 5 6th — 3 7th — 3							

* Immunology (18B11BT513) will only be offered to the student, if he has already studied Bioprocess Engineering (15B11BT511) as a core course.

** Immunology Lab (18B17BT573) will only be offered to the student, if he has already studied Bioprocess Engineering Lab (15B11BT571)

Minor in Bioinformatics

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Engg Science	20B11BI311	Bioinformatics Data Management	3	1	0	**4**	**4**
2	Engg Science	20B17BI371	Bioinformatics Data Management Lab	0	0	2	**1**	**2**
3	Professional Core	18B11BI414	Programming Languages for Bioinformatics	3	0	0	**3**	**3**
4	Professional Core	18B17BI474	Programming Languages for Bioinformatics Lab	0	0	2	**1**	**2**
5	Professional Core	18B11BI512	Scripting Languages for Bioinformatics	3	0	0	**3**	**3**
6	Professional Core	18B17BI572	Scripting Languages for Bioinformatics Lab	0	0	2	**1**	**2**
7	Professional Core	18B11BI612	Computer Aided Drug Design	3	0	0	**3**	**3**
8	Professional Core	18B17BI672	Computer Aided Drug Design Lab	0	0	2	**1**	**2**
9	Professional Elective	18B1WBI731	Computational Systems Biology	3	0	0	**3**	**3**
						Total	**20**	**24**
	Credit breakup: Semester Credits 3rd 5 4th 4 5th 4 6th 4 7th 3							

Proficiencies in Biotechnology & Bioinformatics

B. Tech Biotechnology Proficiency: Industrial Biotechnology

The courses included in Industrial Biotechnology proficiency are designed to give more exposure and insights to students in the specific domain so that they will have an edge to be employed in such a sector. Applications of industrial Biotechnology are widespread across multiple industries like food, pharmaceutical, chemical, bio-products, textiles, medicine, nutrition, and environmental conservation etc.

S.No.	Subject Code/Semester	Name of the Subjects	Course Hours			Credits	Total Hours
			L	T	P		
1	Semester 5	Industrial Plant Tissue Culture	3	0	0	**3**	**3**
2	Semester 6	Manufacturing Process and Industrial Products	3	0	0	**3**	**3**
3	18B1WBT731	Industrial Enzymes Technologies	3	0	0	**3**	**3**
4	14B1WBT741	Bioresources and Industrial Products	3	0	0	**3**	**3**
5	Semester 8	Food Processing and Engineering	3	0	0	**3**	**3**
6	Semester 8	Bioprocess Modelling and Simulation	3	0	0	**3**	**3**
7	18B19BT791	Major Project Part I	0	0	10	**5**	**10**
8	18B19BT891	Major Project Part II	0	0	14	**7**	**14**
					Total	-	-

B. Tech Biotechnology Proficiency: Medical Biotechnology (Approved Elective Courses)

Medical biotechnology deals with the healthcare and pharmacy sectors. Discoveries in this field mostly pertain to drugs, vaccines, diagnostics etc. The field of medical biotechnology is experiencing rapid growth in recent years, leading to the development of several innovative techniques for preventing, diagnosing and treating diseases. As ample thrust is being imparted globally to the discipline of Medical Biotechnology, this proficiency is proposed with an aim to impart more knowledge and exposure to interested students in this area.

S.No.	Subject Code/Semester	Name of the Subjects	Course Hours			Credits	Total Hours
			L	T	P		
1	18B1WBT532	Comparative & Functional Genomics	3	0	0	**3**	**3**
2	18B1WBT632	Infectious Diseases	3	0	0	**3**	**3**

3	18B1WBT633	Nano-Biotechnology	3	0	0	**3**	**3**
4	14B1WBT739	Stem Cells and Regenerative Medicines	3	0	0	**3**	**3**
5	18B1WBT831	Genetic Counselling	3	0	0	**3**	**3**
6	18B1WBT833	Diagnostics & Vaccine Manufacture	3	0	0	**3**	**3**
7	18B19BT791	Major Project Part I	0	0	10	**5**	**10**
8	18B19BT891	Major Project Part II	0	0	14	**7**	**14**
					Total	-	-

B. Tech. Bioinformatics Proficiency: Biomedical Informatics

Biomedical instrumentation, techniques, signal and image processing is the utmost requirement in current healthcare sectors. With the increase in several lifestyle diseases; health care is on priority to facilitate human beings through technological interventions. Biomedical Informatics proficiency will provide a strong platform to our students to improve their scientific and practical research in the field of health informatics.

S.No.	Subject Code/Semester	Name of the Subjects	Course Hours			Credits	Total Hours
			L	T	P		
1	Semester 5	Applied Medical Signal Processing	3	0	0	**3**	**3**
2	Semester 5	Computational Biomedical Image Analysis	3	0	0	**3**	**3**
3	Semester 6	Cheminformatics	3	0	0	**3**	**3**
4	Semester 6	Clinical Data Management System	3	0	0	**3**	**3**
5	14B1WBT739	Stem Cells and Regenerative Medicines	3	0	0	**3**	**3**
6	Semester 8	Bioprocess Modelling and Simulation	3	0	0	**3**	**3**
7	18B19BI791	Major Project Part I	0	0	10	**5**	**10**
8	18B19BI891	Major Project Part II	0	0	14	**7**	**14**
					Total	-	-

B. Tech. Bioinformatics Proficiency: Systems Biology (Approved Elective Courses) With the advent of new technologies and generation of deluge of genomic and proteomic data, these is a need to deal with it in a collective manner and systems biology is the solution for that. Computational Systems Biology provides the study of biological systems for their annotation towards solving complex and polygenic diseases and other global problems. This proficiency will help our students to learn this upcoming area with an aim to achieve state-of-the-arts specializations. It will help them to establish a new team of bioinformaticicans with systems and synthetic biology preparations.

S.No.	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
			L	T	P		
1	18B1WBI531	Structural Bioinformatics	3	0	0	**3**	**3**
2	18B1WBT532	Comparative & Functional Genomics	3	0	0	**3**	**3**
3	18B1WBT632	Infectious Diseases	3	0	0	**3**	**3**
4	18B1WBI731	Computational Systems Biology	3	0	0	**3**	**3**
5	18B1WBI834	NGS Data Analysis & Applications	3	0	0	**3**	**3**
6	18B1WBI831	Computational Molecular Evolution	3	0	0	**3**	**3**
7	18B19BT791	Major Project Part I	0	0	10	**5**	**10**
8	18B19BT891	Major Project Part II	0	0	14	**7**	**14**
					Total	-	-

Industrial Plant Tissue Culture

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Cell Culture Technology

Course Objectives:

1. To provide an insight and understanding about different aspects of plant cell and tissue culture technologies
2. Learn about latest scientific and commercial advancements in plant cell and tissue culture.
3. Apply basic knowledge for developing novel products and production for commercialization

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To enable students for applying the knowledge about basic techniques of plant cell and tissue culture.	Familiarity
CO-2	To apply the learnt techniques for solving constraints linked with production of in vitro plants and phytochemicals through cell and tissue culture technologies	Analytical and Technical skills
CO-3	Able to learn the strategies and techniques for conservation of plant germplasm	Assessment
CO-4	To enable students for exploring their avenues for entrepreneurship through skill development	Usage
CO-5	Able to apply knowledge of plant biotechnology for effective planning and strategizing of projects .	Technical
CO-6	Able for developing skills for benefit generation and utilization of plant tissue culture techniques for commercialization and entrepreneurship	Analytical and Technical skills

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Introduction of plant tissue culture, historical events and different commercial units associated	3
2	**Different Techniques :**Organ culture, somatic embryos, haploids , callus and suspension cultures applied in different plant species Protoplast isolation, culture and regeneration. Somatic hybridization and cybridization.	9
3	**Conservation techniques:**In situ and ex situ conservation of plant germplasm including cryopreservation	4
4	**Plant cell and tissue modification techniques:**Plant genetic modification by direct and indirect methologies Development of Transgenics plants Somaclonal variations Cartagena protocols and CBD	6
5	**Secondary metabolites in plants:**Secondary metabolites, classifications and biosynthesis and accumulation. Production of secondary metabolites through cell culture and their commercial production and usage. Quantification of secondary metabolites	6
6	**Legal perspectives:**Plants Breeder's Right, Convention on Biological Diversity ,Biodiversity Act and Traditional Knowledge Act	4
7	**Large scale production:**Hydrophonics and Aquaphonics set ups along with their industrial applications Bioreactor setups for large scale production of planting material and products	4
Total lectures		**42**

Suggested Text Book(s):

1. Micropropagation: Technology and Application by P.C. Debergh and R.H. Zimmerman Kluwer Academic Publishers.
2. Introduction to plant tissue culture by M. K. Razdan.

3. Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application Book by Ashwani Kumar, Jafargholi Imani, and Karl-Hermann Neumann

Suggested Reference Book(s):

1. Plant Culture Media, Volume 1,Formulations and Uses by E.F. George, D.J.M. Puttock and H.J.George.
2. Plant cell and tissue culture for the production of food ingredients By Tong-Jen Fu, Gurmeet Singh, Wayne R. Curtis, American Chemical Society.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.7**
CO-2	2	2	1	2	2	2	1	1	1	1	1	2	**1.5**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.7**
CO-4	2	2	3	3	2	1	1	1	2	2	2	2	**1.9**
CO-5	2	1	1	1	2	1	2	1	1	1	1	1	**1.2**
CO-6	2	1	1	2	2	2	1	1	2	2	2	2	**1.6**
Average	**3.4**	**2.8**	**1.6**	**2**	**2.1**	**1.3**	**1.1**	**1**	**1.6**	**1.6**	**1.5**	**1.8**	

Manufacturing Process and Industrial Products

COURSE CODE :

COURSE CREDITS : 03

: 3-0-0

CORE/ELECTIVE : Elective

Pre-requisite: None

Course Objectives:

The objective of this course is to learn the advanced technologies in manufacturing of therapeutic and plant-based biotechnological products which coupled with the industrial-scale knowledge of biotechnological production and latest downstream process scheme and techniques.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Manufacturing technologies for Therapeutic and Pharmaceutical compounds	Familiarity and Usage
CO-2	Manufacturing of plant-based bioactive /secondary compounds	Familiarity and Usage
CO-3	Manufacturing of Alcoholic beverages	Familiarity and Usage
CO-4	Manufacturing Biotechnological products: Industrial scale approaches	Familiarity and Usage
CO-5	Manufacturing technologies for Biotechnological products: Advanced DSP Approaches	Familiarity and Usage

Course Contents:

Unit	Contents	Lectures required
1	**Manufacturing technologies for Therapeutic and Pharmaceutical compounds** Microbial production Technology of Therapeutic enzymes: L-asparaginase, L-glutaminase, Pencillin acylase and nattokinases Biocatalysts towards production of pharmaceutically active racemic mixtures	12
2	**Manufacturing of plant-based bioactive**	7

	/secondary compounds Plant-Associated Microorganisms (Endophytes) as a New Source of Bioactive Natural Products Biotechnological Methods for Selection of High-Yielding Cell Lines and Production of Secondary Metabolites in Medicinal Plants	
3	**Manufacturing of Alcoholic beverages** Wine Biotechnology: Manufacturing and technological considerations of White, Red, Sparkling, Fortified, and Cider	5
4	**Manufacturing Biotechnological products: Industrial scale approaches** Industrial-Scale Fermentation Scale-Down: Simulating Large-Scale Cultures in the Laboratory	9
5	**Manufacturing technologies for Biotechnological products: Advanced DSP Approaches** Schematic approaches for the Isolation and Purification of Fermentation Products Advances in Biochromatography: Dye-ligand Affinity chromatography, Immobilized metal-ion affinity chromatography (IMAC) and Immobilized histidine ligand affinity chromatography	9
	Total Lectures	42

Suggested Text Book(s):

- Current Developments in Biotechnology and Bioengineering: Production, Isolation and Purification of Industrial Products by Ashok Pandey, Sangeeta Negi, Carlos Ricardo Soccol

- Medicinal Plant Biotechnology by Oliver Kayser and Wim J. Quax
- Current Developments in Biotechnology and Bioengineering: Food and Beverages Industry Edited by Ashok Pandey, Maria A´ngeles Sanroma´n, Guocheng Du, Carlos Ricardo Soccol, Claude-Gilles Dussap
- Industrial Biotechnology by Christoph Wittmann and James C. Liao
- Biochromatography: Theory and practice Edited by M.A.Vijayalakshmi

- Review and research articles from Science Direct, Springer, Wiley and PubMED publishers

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	2	3	1	1	2	2	3	2	2	1	2
CO-2	1	2	2	2	2	1	-	2	2	2	1	3
CO-3	2	2	2	2	2	2	1	1	2	-	2	2
CO-4	2	3	2	1	2	1	-	1	3	2	-	2
CO-5	1	3	1	3	2	2	1	2	1	2	1	3

Industrial Enzymes Technologies

COURSE CODE:18B1WBT731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Enzyme production purification and applications

Course Objectives:

1. The objective of the course is to develop an understanding of important aspects of production and purification of industrially important enzyme and their application in industry.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To develop an understanding of basic concepts of enzymes.	Familiarity
CO-2	To understand the basic mechanism of action and working behaviour of enzymes	Assessment
CO-3	To familiarize the students with various applications of enzymes in laboratory as well as Industrial scale.	Assessment
CO-4	To conceptualize about immobilized enzyme technology, and other specific enzymes and their applications.	Usage
CO-5	To familiarize the students with present potential of enzyme in industrial application and improved activity of the enzyme using various molecular biology techniques.	Usage
CO-6	To understand the principle and function of enzyme in various adverse conditions like high temperature and pH(s).	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Enzymes: Basic concepts:**Enzymes as powerful and highly specific catalysts, Classification of enzymes, free energy and enzymes, the formation of the transition state, catalytic strategies. General properties: Enzyme specificity, stability and structure, Factors affecting enzyme activity; effect of pH and Temperature, Substrate and Enzyme concentration.	5

2	**Enzyme kinetics**: Michaelis-Menten kinetics, evaluation of parameters in the Michaelis-Menten equation, 3-D structure of active site, Kinetics of single and bi-substrate enzyme catalysed reactions, Inhibition & its kinetics.	**5**
3	**Enzyme preparation techniques:** Sources of enzymes, production,Recovery and purification of intracellular products: cell disruption, chromatographic techniques. Analytical assays of purity level of enzymes.	**3**
4	**Enzyme preparation and application in industries:** Application of enzymes in leather, glucose syrup production, starch and sugar industry, Dairy and food industry, Beverage industry, Textile industry. Hydrolysis of starch and cellulose. Catalytic functions of Cellulase, lipase, esterase laccase amylase, glucose isomerase, protease, xylanase, invertase, peroxidises. Other applications of enzymes in solution: medical applications of enzymes, non-hydrolytic enzymes in current and developing industrial technology.	**10**
5	**Enzyme engineering:** Mechanisms and manifestations of protein denaturation. Strategies for enzyme stabilization: Physical and chemical modifications, Selection, directed evolution and Rational design. design and construction of mutant enzymes, Bifunctional and polyfunctional enzyme, Enzyme in organic solvents.	**5**
6	**Immobilized-enzyme technology**: Introduction, enzyme immobilization method: Entrapment, carrier-binding and cross-linking method. Medical and analytical applications of immobilized enzymes.	**8**
7	**Specified Enzymes and applications:** Thermozymes, Cold adapted enzymes, Ribozymes, Hybrid enzymes, Diagnostic enzymes, Therapeutic enzymes: Characteristics, principles and applications.	6
Total Lectures		**42**

Suggested Text Book(s):

1. Devasena, T., "Enzymology", 1st ed., Oxford University Press, 2010
2. Berg, J.M., Tymoczko, J.L. and Stryer, L., "Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2002.
3. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.

Suggested Reference Book(s):

1. Pye, E.K. and Wingard, L.B., "Enzyme Engineering II", Plenum Press, 1974.
2. Illanes A, "Enzyme Biocatalysis", Springer Science, 2008.

Other useful resource(s):

https://nptel.ac.in/course.php?disciplineId=102

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	1	1	2	2	3	2	2	1	2	1.9
CO-2	1	2	2	2	2	1	-	2	2	2	1	3	1.8
CO-3	2	2	2	2	2	2	1	1	2	-	2	2	1.8
CO-4	2	3	2	1	2	1	-	1	3	2	-	2	1.9
CO-5	1	3	1	3	2	2	1	2	1	2	1	3	1.8
CO-6	1	1	-	2	2	2	2	1	2	2	1	3	1.7
Average	1.5	2.1	1.6	1.8	1.8	1.6	1	1.6	2	2	1.2	2.5	

Bio-resources and Industrial Products

COURSE CODE: XXXXXX
COURSE CREDITS: 3
CORE / ELECTIVE: Elective
L-T-P: 3-0-0

Pre-requisite: Fundamental Chemistry and Advanced Biology

Course Objectives:

1. The objective of the course is to develop an understanding of different type of bio-resources.
2. To learn about the various industrial products that is derived from microbes, plant, and animal.
3. Learn about bio-renewable and non renewable products.

Course Outcomes

S. No.	Course Outcomes	Level of Attainment
CO I	Introduction to Bio-resource, use of Biodiversity and different Scale of Bio-resource Engineering, Processing Technology	Familiarity
CO II	Introduction to different bio-resources for industrial product development	Assessment & Technical
CO III	Microbial bio-resources: Isolation and Application in food, medicine and other industrial product.	Assessment & Technical
CO IV	Novel plant and animal bio-resources: Isolation and Application in food, medicine, cosmetics and textile industries	Usage
CO V	Fundamental understanding of Processing Technology: processes for converting Raw material to bio-based product	Usage

Topic Covered:

S. No.	Unit	Topics Covered	Contact Hrs.
1	Overview: Introduction and History	Various definitions and Concept of Bio-resources & Historical background Fundamental concept of bio-resources Engineering and different Scale of Bio-resource Engineering	5
2	Bio-resources for industrial product	Major category of bio-resources: Microbial bio-resources, animal based bio-resources and plant based bio-resources. Value of bio-resources in various industrial product developments.	6
3	Microbial bio-resources and their application in Industries	Use of microbial bio-resources for human welfare: microbial bio-resources in cosmetics, use of microbial resources in food industries and pharmaceutical industries. Useful Microorganisms for Environmental Sustainability: Application of Heavy Metal Tolerant Consortia for Surface Water Decontamination in Natural and Artificial Wetlands	8
4	Plant based bio-resources and their application in Industries	Use of Plant based bio-resources for human welfare: in bio-cosmetics (Aloe vera, Crocus sativus and Santalum album), bio-preservatives (vinegar, sugar), use of plant resources in pharmaceutical industries, SAR,	8

		antioxidant, anticancer, immunostimulant drug development. Application in food industries: food supplement, beverages, fodder, bio-sweetener etc.	
5	Animal based bio-resources and their application in Industries	Use of Animal based bio-resources for human welfare: in dairy industries (various dairy product: cheese, milk, ice cream etc), bio-cosmetics. In textile industries (Pashmina, angora wool), Honey, meat industries etc.	8
6	Processing Technology	Bio-refinery Concept, processes for converting Raw material to bio-based product, novel development in Processing Technology.	5
7	Case Study	Case study of lignocellolose-Ethanol Processing	2
	Total Number of Lectures		**42**

Methodology

The course will be covered through lectures. Apart from discussions on topics covered in lectures, assignments and conceptual problems will also be given.

TEXT BOOKS

1	Novel Plant Bioresources: Applications in Food, Medicine and Cosmetics, Ameenah Gurib-Fakim, WILEY.
2	Emerging Bioresources with Nutraceutical and Pharmaceutical Prospects: Seema Patel San Diego State University, San Diego, California, USA, Springer
3	Dairy Chemistry and Biochemistry P.F. FOX and P.L.H. McSweeney Department of Food Chemistry University College, Cork Ireland

REFERENCE MATERIAL

1	Review articles on relevant topics from diverse sources
2	Animals in Traditional Folk Medicine: R. R. N. Alves, I. L. Rosa. Springer Heidelberg New York Dordrecht
3	Renewable Bio-resources Scope and Modification for Non-food Applications: C. V. Stevens, R. Verhé, Wiley

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	Average
CO-1	2	2	1	2	2	2	2	1	2	2	2	2	2	2	1.8
CO-2	1	2	1	2	2	2	2	2	2	2	1	2	3	2	1.8
CO-3	2	3	3	3	3	2	3	2	2	1	2	2	3	2	2.3
CO-4	2	3	3	3	3	2	3	2	2	1	2	2	3	2	2.3
CO-5	2	2	3	3	2	2	3	2	2	1	2	2	3	2	2.3
Average	1.8	2.4	2.2	2.6	2.4	2.0	2.6	1.8	2.0	1.4	1.8	2.0	2.8	2.0	

Food Processing and Engineering

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE:

: 3-0-0

Pre-requisite: Biology

Course Objectives

1. This course is designed to make the students familiar with the processes employed in the manufacture of food products and Engineering aspects of food processes at commercial scale.
2. Students specializing in food engineering learn to apply engineering principles and concepts to handling, storing, processing, packaging, and distributing food and related products.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Students become aware of Concept of Food Processing and Engineering.	Familiarity
CO II	Students will acquire knowledge about processing techniques of different food commodities.	Familiarity
CO III	Will develop understanding the basic principles and equipments used in food Processing.	Assessment
CO IV	Students will learn engineering aspects and equipments used of common unit operations of food processing.	Usage
CO V	Will develop understanding of food packaging methods and trends in this area	Usage

Topic Covered

S. No.	Contents	Contact Hrs.
	Module I Food Processing	
1	Food Processing and Engineering Concept, Scope, Importance and Subject matter	1
2	Food Fermentation Benefits of fermentation - nutritive value of fermented food, Microorganisms in fermented foods: Case studies of manufacturing of some non alcoholic Fermented Foods: Sauerkraut, Soy based fermented products, dairy products	4
3	Fruit Processing Techniques Apple Processing, Anola Processing, Grapes processing, Banana Processing, Citrus Processing, Guava Processing, Mango Processing, Pineapple Processing	5
4	Vegetable Processing Techniques Tomato Processing Cabbage Processing, Carrot Processing, Cauliflower Processing, Garlic Processing, Onion Processing, Ginger Processing, Potato Processing	5
	Module II Food Process Engineering	
5	Basic Principles and Equipments used in Food Processing	8

	Steam generation and utilization, Refrigeration, Heat exchange and heat exchange Equipments	
6	Principles and Equipments involved unit operations of food processing Size reduction and separation, Evaporation and evaporation equipments, Dehydration and Drying equipments, Material handling and transportation	13
7	Food Packaging Thermal and Non-thermal processing for packaging, packaging material, Advanced and innovative packaging technologies	3
8	Plant Design, Location and Equipment Layout**:** General Principles, Design and Functionality of Building, Design and Fabrication of Equipments, Plant Location, Role of Food Engineers'	3
	Total Number of Lectures	42

REFERENCE & TEXT BOOKS

1. Guide to Post Harvest Uni Operations – NK Dhamsaniya, Kalyani
2. Food Microbiology: Fundamentals and frontiers - M.P. Doyle, L.R. Beuchat and Thomas J. Montville, (2001), ASM press, USA
3. Post Harvest Management and Processing of Fruit and Vegetable – NS Tathore GK Mathur and SS Chasta
4. Fundamental Of Food Engineering - DG Rao PHI Learning Pvt Ltd

Course outcomes	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	2	2	3	1	1	2	2	3	2	2	1	2
CO-2	1	2	2	2	2	1	-	2	2	2	1	3
CO-3	2	2	2	2	2	2	-1	1	2	-	2	2
CO-4	2	3	2	1	2	1	-	1	3	2	-	2
CO-5	1	3	1	3	2	2	1	2	1	2	1	3

Bioprocess Modelling and Simulation

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

The objective of this course is to learn the modeling and optimization approaches for model and optimize the different biotechnological processes. This approach is helpful to scale up the biotechnologal process and improves the yield of Biotechnological products.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Introduction and Importance of Modelling in Bioprocess technologies	Familiarity
CO-2	Role of optimization in enhanced yields in Bioprocess systems	Familiarity
CO-3	Necessity of Design of experiments in modeling and optimization approaches	Familiarity
CO-4	Types of modeling and optimization approaches for Bioprocess systems	Usage
CO-5	Application of modeling coupled optimization tools for bioprocess systems	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Modeling and Different Types of models	**5**
2	Introduction to optimization and classical optimization techniques	5
3	Introduction to experimental Design and Types of Experimental Designs	8
4	Modelling & optimization through Response Surface Methodology and Taguchi Methodology	**8**

5	Modeling based on neural networks and Experimental validation of neural network models	6
6	Evolutionary and swarm intelligence based optimization approaches for optimization of Biological process	10
Total lectures		**42**

Suggested Text Book(s):

4. Modelling and Simulation by G. Francis,
5. Modelling and Optimization of Biotechnological Processes by Chen, Nguang and Chen, Springer
6. Biologically Inspired Algorithms for Financial Modelling by Brabazon · Michael O'Neill, Springer
7. Modelling microbial responses in Food by McKeller and Lu, CRC Press
8. Engineering optimization by S.S.Rao, Wily-Interscience
9. Extraction and optimization of Food Engineering by Coustantina Tzia, Marcell-Dekker
10. Design and optimization in Organic synthesis by Carlson and Carlson, Elsevier
11. Design and Analysis of Experiments by Dean and Voss, Springer
12. Design and Analysis of Expeiments by Montgomery, John Wiley & Sons
13. Design of Experiments Using the Taguchi Approach by Roy, Ranjit K, John Wiley & Sons, Inc. (US)
14. Design and Analysis of Experiments by Hinkelmann and Kempthorne, Wiley Interscience
15. Differential Evolution by Feoktistov, Springer
16. Response surface methodology and related topics by Khuri, World Scientific
17. Particle swarm optimization by Clerc, ISTE
18. Soft computing by D.K.Prathihar, Narosa Publishers

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	1	1	1	1	1	1	
CO-2	3	3	3	3	3	1	1	1	1	1	1	3	
CO-3	3	3	2	3	2	3	2	1	1	1	2	1	

CO-4	3	3	3	2	3	2	1	1	1	1	1	1	
CO-5	2	2	3	3	3	3	1	1	1	1	1	1	
Average													

Stem Cells and Regenerative medicines

COURSE CODE: 14B1WBT739

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic understanding of biology and cell culture

Course Objectives

The objective of the course is to develop an understanding of important concepts and design aspects of bioreactors and their functioning and scale up.

Course Outcomes

CO I	Able to understand current medicine therapy and embryonic stem cell
CO II	Able to understand different tissues and adult stem cell
CO III	Able to understand heart, muscle and neural stem cells
CO IV	Able to understand regenerative medicine and application of stem cells
CO V	Able to understand tissue engineering

Course Content

S. No.	Unit	Topics Covered	Contact Hrs.
1	Introduction	Overview of current medicine and therapy, introduction to stem cells, and regenerative therapy. Totipotency, pluripotency, multipotency, progenitors, etc. Different types of stem cells –embryonic , adult stem cells, induced pluripotent cells (iPSCs), localisation, niche, etc.	4
2	EMBRYONIC STEM CELLS, NUCLEAR REPROGRAMMING, AND STEM CELL FATE	Development of Diverse Hematopoietic Cell Populations from Human Embryonic Stem Cells Using Embryonic Stem Cells as a Model of Pancreatic Development Isolation and culture of mesenchymal stem cells	8
3	ADULT STEM CELLS	Introduction to different tissues and systems of human body. Multipotent Adult Progenitor Cells, localisation and stem cell proliferation. Neural stem cells, bone marrow cells, Ocular Surface Epithelial Stem Cells, etc	4

4	STEM CELLS FOR MUSCLE AND HEART	Stem Cells in Skeletal Muscle Regeneration, Myogenic Precursor Cells in the Extraocular Muscles, Treating Coronary Heart Disease with Progenitor-Cell-based Repair, Postnatal Stem Cells for Myocardial Repair.	6
5	STEM CELLS FOR THE NERVOUS SYSTEM	Use of a β -Galactosidase Reporter Coupled to Cell-Specific Promoters to Examine Differentiation of Neural Progenitor Cells In Vivo and In Vitro From Neural Stem Cells to Neuroregeneration Cochlear Stem Cells/Progenitors Intravascular Delivery Systems for Stem Cell Transplantation in Neurologic Disorders Stem Cell Strategies for Treating Inner Ear Dysfunction	9
6	Regenerative Medicine	Regenerative Medicine : Overview, Gene therapy, regenerative medicine, Bioprinting, Stem Cells and Regenerative Medicine in diseases, Genetic Reprogramming	4
7	Tissue Engineering	Tissue engineering overview, Cells and Biomaterials : The Tissue engineering Approach, An overview of various Scaffolds, Regulation of cell function in tissue engineering, scaffold fabrication techniques, Bioreactor in Tissue Engineering, Transplantation Immunology: Organ and Tissue Transplantation Immunosuppressive Agents, Immunosuppressive Therapy	7
		Total Number of Lectures	**42**

Methodology

The course will be covered through lectures. Apart from discussions on topics covered in lectures, assignments and numerical problems will also be given.

TEXT BOOKS

1	Krishnarao Appasani and Raghu K. Appasani, Stem Cells & Regenerative Medicine, Humana Press
2	Walter C. Low and Catherine M. Verfaillie, Stem Cells and Regenerative Medicine, World Scientific Publishing Co. Pte. Ltd USA (2008)

Course out Come

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
	Stem cell and regenerative medicine													
CO1	2	2	2	2	2	3	1	2	1	2	2	2	3	2
CO2	2	2	3	1	1	2	1	3	2	1	2	2	3	2
CO3	3	2	3	2	2	3	1	2	2	2	2	2	3	2
CO4	3	2	3	3	3	3	3	2	2	2	3	2	3	3
CO5	3	2	3	3	3	3	3	2	2	2	3	2	3	3
	2.6	**2**	**2.8**	**2.2**	**2.2**	**2.8**	**1.8**	**2.2**	**1.8**	**1.8**	**2.4**	**2.0**	**3**	**2.4**

Chemoinformatics

COURSE CODE: XXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: None

Course Objectives:

1. To learn the basics of chemoinformatics and to design potential lead molecules against any disease that may be explored further as a potential candidate for the drug development.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Introduction to chemoinformatics	Familiarity
CO2	Design and optimize lead molecules against drug target, and using ligand-based approach	Usage
CO3	Determination of pharmacophore from lead molecules and active sites and use of pharmacophore for lead discovery	Usage
CO4	Development of potential drug molecule and pharmacophore databases for virtual screening	Assessment
CO5	Quantum chemistry fundamentals	Familiarity
CO6	Bioavailability prediction of a drug and working capability in drug designing software like, Discovery Studio and molecular dynamics software like AMBER 8.0, On-line tools, etc.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction	4
2	Quantum chemistry	3
3	Receptor Fitting (Lead discovery& refinement)	9
4	Receptor Fitting (Lead optimization)	4
5	Receptor Mapping (Pharmacophore)	5
6	Representing 2D & 3D structures, 2D chemical database	4
7	Receptor Mapping (Quantitative structure activity relationship (QSAR))	6

8	Fragment-based Lead Discovery	4
9	ADMET	4
	Total	42

Suggested Text Book(s):

19. David C Young : Computational Drug Design (A guide for computational and medicinal chemists) Wiley & Sons, Inc., New Jersey, USA

20. Holtje H.-D, Sippl W., Rognan D. and Folkers G. : Molecular Modeling, Basic Principles and Applications Wiley-VCHGmbH & Co. KGaA

21. Leach AR : Molecular Modeling: Principles and Applications: Prentice Hall, Edinburg UK.

22. Zartler ER & Shapiro MJ : Fragment-based Drug Discovery (A practical approach), Wiley & Sons, Inc., West Sussex, UK

Flower DR : Drug design: cutting edge approaches, RSC publication, Cambrige, UK

Suggested Reference Book(s):

3. Merz KM, D Ringe, : Drug Design: Structure and Ligand-based Approaches. Reynolds CH Cambridge University Press

4. Opera TI : Chemoinformatics in Drug Discovery, Wiley-VCH, GMBH

5. Hubbard RE : Structure-based drug discovery (An overview), RSC publication, Cambrige, UK

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Average	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Clinical Data Management System

COURSE CODE: XXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Basic Knowledge of Biology and Computers

Course Objectives:

1. This course is designed for individuals interested in the scientific, policy, and management aspects of clinical trials. Topics include types of clinical research, study design, treatment allocation, randomization and stratification, quality control, sample size requirements, patient consent, storage of the data and interpretation of results along with registration in clinical trial databases. Students design a clinical investigation data base in their own field of interest.

Course Outcomes:

CO I	To have the background essential for understanding the rationale behind clinical trials
CO II	To Understand database principles and data management
CO III	To understand the basic principles of clinical research
CO IV	To utilize the basic knowledge of clinical research into applied workflow of drug development.
CO V	To knowhow for setting up a clinical trial and managing the data along with the database set-up.

Course Content:

S.No.	Topic	No. of Lectures
1	Introduction , Pre Clinical Vs Clinical trials, Objectives and Principles, Various Phases of Clinical Trial	4
2	Statistics in clinical research	7
3	Data collection and management systems; Decision Support Systems	7
4	Study Design & trial consideration	4
5	Study population, Randomization process, Blinding, Sample size, Recruitment	2

6	Ethics, requirements pertaining to clinical research	2
7	Quality Control in clinical trials	2
8	Clinical trial Registries	4
9	Participant adherence, Survival analysis, Closure	2
10	Reporting and analysis evaluation of data	2
11	Multicenter trials	2
12	Globalization of clinical trials	2
13	Clinical trial scenario in India	2
	Total	**42**

TEXT AND REFERENCE BOOKS

1	Clinical Data Management (Second Edition) by Richard K. Rondel, Sheila A. Varley, Colin F. Webb. Wiley Publications.
2	Practical Guide to Clinical Data Management (Second Edition) by Susanne Prokscha. CRC Publications.
3	Statistical Aspects of the Design and Analysis of Clinical Trials by Brian S. Everitt and Andrew Pickles. Imperial College Press.

XXXXXXXX: Bioinformatics Data Management

Course Credit: 4 (3-1-0)
Semester: III

Introduction

Bioinformatics is a highly interdisciplinary domain and is an excellent source of diversified data. This diversified data needs attention in the collection, analysis and management. Database Management Systems (DBMS) consists of a set of interrelated data and a set of programs to access that data. They underpin any computer system and are therefore fundamental to any programme of study in information science and engineering. An understanding of DBMS is crucial in order to appreciate the limitations of data storage and application behavior and to identify why performance problems arise. With the advent of new technologies in Biological sciences, enormous amount of data is being generated in last two decades. DBMS can support the management of this data through Bioinformatics domain.

Students who complete this course are expected to develop the ability to design, implement and manipulate databases for various biological and medical science domains. Students will apply and build databases for various day to day real life scenarios and real life applications for several diseases and biomedical applications. The course will by and large be structured but will introduce open-ended data base problems for biological data.

Course Objectives (Post-conditions)

Knowledge objectives:

- Understand diversity of biological and biomedical data.
- Ability to build normalized databases.
- Knowledge of Entity Relationship Modeling.
- Familiarity with SQL, embedded SQL and PLSQL.
- Familiarity with query processing and query optimization techniques.
- Understanding of transaction processing.
- Ability to handle recovery and concurrency issues in biological systems.
- Familiarity with ODBC, JDBC.

Application objectives:

- Develop the ability to design, implement and manipulate databases.
- Introduce students to build database management systems.
- Apply DBMS concepts to various biological and biomedical applications.

Expected Student Background (Preconditions)

- Introduction to any programming language (Preferably, C/C++)
- Data Structures

Topics Outline:

S NO	Topics	Hrs
1	To understand complexity of biological data and Introduction to Database Management Systems	2
2	Introduction to Conceptual Modeling	3
3	Relational Model	2
4	Relational Languages like SQL (including JDBC for database connectivity, ODBC, JDBC and SQLJ)	5
5	Integrity and Security	2
6	Database Design with special relevance to biological data dimensions	5
7	Object oriented and Object Relational Database	4
8	File Storage Methods	2
9	Query Optimization	2
10	Transaction Management	6
11	Database System Architecture	2
12	Development of template databases of biological and biomedical domains	4
13	Case Studies of various Bioinformatics databases	3
	Total	42

References

1. Silberschatz, Korth and Sudarshan, "Database System Concepts", 6th Edition,McGraw Hill, 2010
2. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, Pearson, Addison-Wesley, 2010
3. C.J. Date, "An Introduction to Database Systems", 8th Edition, Addison-Wesley, 2003
4. Ramakrishnan & Gherke, Database Management Systems, 2nd Edn., McGraw
5. Connolly and Begg, "Database Systems", 4th Edn., Addison-Wesley, 2005
6. Toby, Lightstone and Jagadish, "Database Modeling and Design", 5th Edn, Elsevier, 2011
7. Coronel and Rob, "Database Systems", 9th Edn., Cengage, 2011
8. IEEE / ACM Transactions on Database Systems (TODS)
9. DBMS related Journals

Evaluation Scheme:

S.No	Examination	Marks
1	T-1	15
2	T-2	25
3	T-3	35
4	*Internal Marks	25

*Internal Marks Breakdown:

Assignments	8 marks (4x2)
Quizzes	12 marks (4x3)
Regularity/Attendance	5 Marks

XXXXXXXX: Bioinformatics Data Management Lab

Course Credit: 1 (0-0-2) Semester: III

Objective:

- Develop the ability to design, implement and manipulate bio oriented datasets.
- Introduce students to build database management systems.
- Apply DBMS concepts to various biological and biomedical domain examples and real life applications.

Learning Outcomes:

- Understand diversity of biological and biomedical data.
- Ability to build normalized databases.
- Knowledge of Entity Relationship Modeling.
- Familiarity with SQL, embedded SQL and PLSQL.
- Familiarity with query processing and query optimization techniques.
- Understanding of transaction processing.
- Ability to handle recovery and concurrency issues.
- Familiarity with ODBC, JDBC.

List of Experiments

S NO	Topics	Hrs
1	**ER Model**: An entity-relationship model (ERM) is an abstract and conceptual representation of data. Entity-relationship modeling is a database modeling method, used to produce a type of conceptual schema or semantic data model of a system. Learn the dimensional diversity of high throughput biological data.	2
2	**EER Model**: In computer science, the enhanced entity-relationship (EER) model is a high-level or conceptual data model incorporating extensions to the original entity-relationship (ER) model, used in the design of databases. It was developed by a need to reflect more precisely properties and constraints that are found in more complex databases.	2
3	**Relational Model**: The relational model for database management is a database model based on first-order predicate logic, first formulated and proposed in 1969 by E.F. Codd. The model uses the concept of a mathematical relation, which looks somewhat like a table of values - as its basic building block, and has its theoretical basis in set theory and first-order predicate logic.	2

4	**1 NF**: First normal form (1NF or Minimal Form) is a normal form used in database normalization. A relational database table that adheres to 1NF is one that meets a certain minimum set of criteria. These criteria are basically concerned with ensuring that the table is a faithful representation of a relation and that it is free of repeating groups.	2
5	**2 NF**: Second normal form (2NF) is a normal form used in database normalization. 2NF was originally defined by E.F. Codd in 1971. A table that is in first normal form (1NF) must	2
	meet additional criteria if it is to qualify for second normal form.	
6	**3 NF**: The Third normal form (3NF) is an important form of database normalization. 3NF is said to hold if and only if both of the following conditions hold: • The relation R (table) is in second normal form (2NF) • Every non-prime attribute of R is non-transitively dependent (i.e. directly dependent) on every candidate key of R.	2
7	**BCNF**: A relation R is in Boyce-Codd normal form (BCNF) if and only if every determinant is a candidate key. The definition of BCNF addresses certain (rather unlikely) situations which 3NF does not handle.	2
8, 9	**SQL-1**: In this lab., we discuss basic SQL operations like creating a table, deleting a table, changing the schema of the table, primary key and foreign key constraints on a table and creating indexes on tables.	4
10, 11	**SQL-2**: Its scope includes efficient data insert, query, update and delete, schema creation and modification, and data access control. In this lab., we discuss SQL operations for populating the tables like inserting into a table, deleting values from a table, and updating the content of the tables.	4
12	**SQL-3**: In this Lab., we discuss SQL operations for viewing the contents of an SQL database, and various operations that we can do using SQL.	2
13, 14	Development of Bioinformatics databases for biological and biomedical domains	4
	Total	28

References

1. “Database Systems: A Practical Approach to design, Implementation and Management”. Thomas Connolly, Carolyn Begg; Third Edition, Pearson Education.
2. "Fundamentals of Database Systems" Elmasri, Navathe, Pearson Education.
3. Bipin C Desai, ?An Introduction to Database Systems?, Galgotia. Publications Pvt Limited, 2001
4. “An Introduction to Database Systems”, C.J.Date, Pearson Education.
5. “A first course in Database Systems”, Jeffrey D. Ullman, Jennifer Windon, Pearson, Education.
6. “Data Management: databases and organization”, Richard T. Watson, Wiley.
7. “ Data Modeling Essentials”, Graeme C. Simxion, Dreamtech.
8. Introduction to Data Base Management, Naveen Prakash, Tata McGraw Hill
9. “Oracle 8i manuals”.

Evaluation Scheme:

1. Mid Term Exam (Viva and Written Exam)	20
2. End term Exam (Viva and Written Exam)	20
3. Lab Records	15
4. Regular Assessment (Quality and quantity of experiment performed, Learning laboratory skills, Attendance etc.)	30
5. Project (Template Bioinformatics Database)	15
Total	**100**