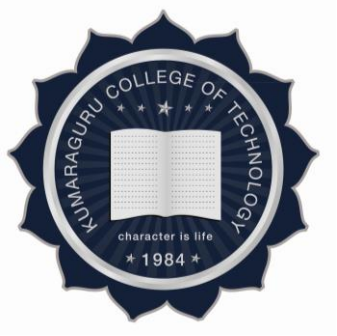
KUMARAGURUCOLLEGE OF TECHNOLOGY, COIMBATORE – 641 049

REGULATIONS 2015

CURRICULUM AND SYLLABUS



III - VIII Semesters

B.Tech Biotechnology

Department of Biotechnology

Vision

Create a strong teaching base in the area of biotechnology through technical knowledge dissemination to the students and to scale new heights in research by etching the concepts of professionalism, social justice, environmental impact and human ethics for welfare of the general public.

Mission

- Disseminate a blending of knowledge acquisition and its application in real-life situations to the students
- Equip the students to adapt to changing global and local needs through well designed curriculum and syllabus
- Groom students to uphold professional ethics and develop leadership qualities
- Train students on issues related to social welfare.

PEOs:

PEO 1
Successful professional career and/ or higher studies by gaining knowledge in fundamental mathematics and biological principles (Cognitive objective).

- PEO 1a Growth in professional career
- PEO 1b Record of higher studies

PEO 2
Provide strong foundation in the core biotechnology courses to evaluate real life problems and to propose biotechnological solutions with economical and social viability (Affectionate objective).

- PEO 2a Potentiality to analyze real life problems
- PEO 2b Appropriate biotechnological troubleshoot with economical and social viability

PEO 3 - Sensitize on environmental, health and bioethical issues, Intellectual property rights, professional ethics and life-long learning through application orientated activities (Behavioural objective).

- PEO 3a Awareness on biotechnological issues and ethics
- PEO 3b Accustomed to life-long learning

POs :

PO1. An ability to apply the knowledge of mathematics, science, and engineering fundamentals in the areas of biotechnology, such as Bioprocess engineering, Genetic Engineering, Bioinformatics, Downstream Processing etc.

PO2. An ability to identify and analyze the complex biotechnology-oriented problems and to nurture the issues by providing appropriate solution

PO3. An ability to design a bio-based system, component or process or protocol to address the essential issues related to public health, environment, society, culture and safety

PO4. An ability to design, analyze, interpret and conclude the biological data using broad research based knowledge

PO5. An ability to educate the appropriate selection and application of current/ modern engineering techniques/ tools in the area of biotechnology

PO6. An ability to inculcate awareness among the students about the impact of various biological issues related to society, ethics, health, culture and safety

PO7. An ability to understand and demonstrate the need for the development of sustainable biotechnological solutions for addressing the environmental issues aligned with society

PO8. An ability to realize, commit and apply professional ethics by means of technology practice

PO9. An ability to inculcate the habit among students to function efficiently as an individual or in multidisciplinary team

PO10. An ability to communicate effectively through verbal and written mode with technical audience

PO11. An ability to create competency in the engineering management, finance principles and its application in multidisciplinary projects

PO12.An ability to recognize the need for *life-long learning* for sustaining professional career.

PSPO1. An ability to apply the knowledge of food/medical biotechnology to solve problems by providing appropriate solutions

PSPO2. An ability to understand and design solutions for biological process engineering related to biotechnology and environment

APPROVED

KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE – 641 049
REGULATIONS 2015(CBCS)
B.TECH BIOTECHNOLOGY
CURRICULUM

Semester-I

Code No.	Course Title	Category	Contact hours	L	T	P	C
THEORY							
U15ENT 101	Technical English	HS	4	3	0	0	3
U15MAT 101	Engineering Mathematics – I	BS	5	3	2	0	4
U15PHT 101	Engineering Physics	BS	4	3	0	0	3
U15CHT 101	Engineering Chemistry	BS	4	3	0	0	3
U15MET 101	Engineering Graphics	ES	5	2	2	0	3
U15CST 101	Structured Programming using 'C'	ES	4	3	0	0	3
PRACTICAL							
U15CHP101	Chemistry laboratory	BS	3	0	0	2	1
U15MEP101	Engineering Practices Laboratory	ES	3	0	0	2	1
U15CSP 101	Structured Programming Laboratory using 'C'	ES	3	0	0	2	1
U15GHP 101	Personal Values -1		1	1	0	0	1
	Total Hours /Credits		35				23

Semester-II

Code No.	Course Title	Category	Contact hours	L	T	P	C
THEORY							
U15ENP201	Business Communication and Personal S	HS	4	2	0	2	2
U15MAT201	Engineering Mathematics – II	BS	5	3	2	0	4
U15PHT206	Applied Physics	BS	3	3	0	0	3
U15CHT206	Chemistry for Biotechnology	BS	3	3	0	0	3
U15EET211	Basics of Electrical and Electronics	ES	4	3	0	0	3
U15BTT201	Biomolecules and Genetics	ES	3	3	0	0	3
PRACTICAL							
U15PHP 201	Physics Laboratory	BS	3	0	0	2	1
U15CSP211	Computing Laboratory	ES	3	0	0	2	1
U15BTP201	Biomolecules and Genetics Laboratory	PC	3	0	0	2	1
U15GHP 201	Personal Values -2	HS	1	1	0	0	1
U15SIP201	Social Immersion Project	HS	2	0	0	2	2
	Total Hours /Credits		28				24

Semester-III

Code No.	Course Title	Category	Contact hours	L	T	P	C
THEORY							
U15MAT308	Probability and Biostatistics	BS	4	3	1	0	4
U15BTT301	Concepts in Biochemistry	PC	3	3	0	0	3
U15BTT302	Microbiology	PC	3	3	0	0	3
U15BTT303	Stoichiometry and Fluid Mechanics in Bioprocess	PC	4	3	1	0	4
U15BTT305	Principles of Bioorganic chemistry	PC	3	3	0	0	3
U15GST006	Product design and development	ES	3	3	0	0	3
PRACTICAL							
U15BTP301	Biochemistry and bioorganic chemistry laboratory	PC	4	0	0	4	2
U15BTP302	Microbiology Laboratory	PC	4	0	0	4	2
U15GHP301	Family Values	HS	1	1	0	0	1
	Total Hours /Credits		29				25

Semester-IV

Code No.	Course Title	Category	Contact hours	L	T	P	C
THEORY							
U15EST006	Basic concepts in Environmental Science	MC	3	3	0	0	3
U15CSP202	Problem Solving Techniques	PC	3	1	0	2	3
U15BTT402	Biotechniques	PC	3	3	0	0	3
U15BTT403	Food Process Engineering	PC	3	3	0	0	3
U15BTT404	Cell and Molecular Biology	PC	3	3	0	0	3
U15BTT406	Biothermodynamics	PC	3	3	1	0	4
PRACTICAL							
U15BTP401	Cell and Molecular Biology Laboratory	PC	3	0	0	3	1
U15BTP402	Unit Operations Laboratory	PC	3	0	0	3	1
U15BTP403	Food Technology and Biotechniques Laboratory	PC	3	0	0	3	1
U15GHP401	Professional Values	HS	1	1	0	0	1
	Total Hours /Credits		28				23

Semester-V

Code No.	Course Title	Category	Contact hours	L	T	P	C
THEORY							
U15BTT501	Genetic Engineering and Genomics	PC	3	3	0	0	3
U15BTT502	Enzyme Technology	PC	3	3	0	0	3
U15BTT503	Bioprocess Engineering	PC	3	3	0	0	3
U15BTT504	Heat and Mass Transfer in Bioprocess	PC	4	3	1	0	4
U15BTT505	Immunology & Microbial Pathogenesis	PC	3	3	0	0	3
OE	Open elective I *	OE	3	3	0	0	3
PRACTICAL							

U15ENP501	Communication Skill Laboratory	HS	3	0	0	3	1
U15BTP502	Enzyme Technology Laboratory	PC	3	0	0	3	1
U15BTP503	Genetic Engineering Laboratory	PC	3	0	0	3	1
U15BTP504	Immunology and Microbial Pathogenesis Laboratory	PC	3	0	0	3	1
U15GHP501	Social Values	HS	1	1	0	0	1
	Total Hours /Credits		32				24

Semester-VI

Code No.	Course Title	Category	Contact hours	L	T	P	C
THEORY							
U15BTT601	Chemical Reaction Engineering	PC	4	3	1	0	4
U15BTT603	Bioprocess Instrumentation and Control	ES	3	3	0	0	3
E1	Elective-I (A, B tracks)	PE	3	3	0	0	3
E2	Elective-II (A, B tracks)	PE	3	3	0	0	3
OE	Open Elective II*	OE	3	3	0	0	3
PRACTICAL							
U15BTP602	Bioprocess Engineering Laboratory	PC	3	0	0	3	1
U15BTP603	Plant Cell Culture Laboratory	PC	4	0	0	4	2
U15BTP604	Mammalian Cell Culture Laboratory	PC	4	0	0	4	2
U15GHP601	National Values	HS	1	1	0	0	1
U15BTP605	Industry Internship/ Innovation Project[1]	PC	0	0	0	0	1
	Total Hours /Credits		29				23

Semester-VII

Code No.	Course Title	Category	Contact hours	L	T	P	C
THEORY							
U15BTT701	Bioinformatics	PC	3	3	0	0	3
U15BTT702	Downstream Processing	PC	3	3	0	0	3
U15BTT703	Biopharmaceutical Technology and Regulatory Practices	PC	3	3	0	0	3
U15BTT704	Bioreactor Modeling and Simulation	PC	3	3	1	0	4
U15BTT705	Comprehensive Exam		0	0	0	0	0
E3	Elective III (C, D Tracks)	PE	3	3	0	0	3
OE	Open elective III*	OE	3	3	0	0	3
PRACTICAL							
U15BTP701	Bioinformatics Laboratory	PC	3	0	0	3	1
U15BTP702	Downstream Processing Laboratory	PC	3	0	0	3	1
U15BTP703	Project (Phase I)	EEC	2	0	0	2	1
U15GHP701	Global Values	HS	1	1	0	0	1
	Total Hours /Credits		29				23

[1] Course offered during summer vacation only.

Semester-VIII

Code No.	Course Title	Category	Contact hours	L	T	P	C
THEORY							
E4	Elective IV (C, D tracks)	PE	3	3	0	0	3
PRACTICAL							
U15BTP801	Project (Phase II)	EEC	18	0	0	18	10
	Total Hours /Credits		21				13

PC: Professional core; PE: professional electives; OE open electives; HS: humanities& sciences; BS: basic sciences; EEC: Employment enhancing courses; MC: Mandatory courses

* Students can choose courses offered by other departments

Only end semester exam will be held for comprehensive exam.

Grand Total Credits 178

PROFESSIONAL ELECTIVES

Code No.	Course Title	Category	Contact hours	L	T	P	C
Elective I							
U15BTE101	Molecular Plant Breeding [A]	PE	3	3	0	0	3
U15BTE102	Food Quality And Safety Assurance [A]	PE	3	3	0	0	3
U15BTE103	Forensic Biotechnology [B]	PE	3	3	0	0	3
U15BTE104	Neurobiology And Cognitive Science [B]	PE	3	3	0	0	3
U15BTE105	Systems Biology [B]	PE	3	3	0	0	3
U15BTE106	IPR And Biobusiness Management*	PE	3	3	0	0	3

Code No.	Course Title	Category	Contact hours	L	T	P	C
Elective II							
U15BTE201	Food Biotechnology[a]	PE	3	3	0	0	3
U15BTE202	Biofertiliser And Biopesticide Development And Control [A]	PE	3	3	0	0	3
U15BTE203	Biotechnology of Value Added Foods [A]	PE	3	3	0	0	3
U15BTE204	Cancer Biology [B]	PE	3	3	0	0	3
U15BTE205	Stem Cells and Tissue Engineering [B]	PE	3	3	0	0	3
U15BTE206	Biomaterials[b]	PE	3	3	0	0	3
U15BTE207	Clinical Research & Data Management[B]	PE	3	3	0	0	3
U15GST002	Total Quality Management*	PE	3	3	0	0	3

Code No.	Course Title	Category	Contact hours	L	T	P	C
Elective III							
U15BTE301	Nanobiotechnology [C]	PE	3	3	0	0	3

U15BTE302	Bioprocess Economics and Plant Design [C]	PE	3	3	0	0	3
U15BTE303	Industrial Biosafety and Bioethics [C]	PE	3	3	0	0	3
U15BTE304	Environmental Toxicology and Occupational Health [D]	PE	3	3	0	0	3
U15BTE305	Environmental Biotechnology [D]	PE	3	3	0	0	3
U15GST003	Principles of Management*	PE	3	3	0	0	3

Code No.	Course Title	Category	Contact hours	L	T	P	C
Elective IV							
U15BTE401	Protein Structures and Engineering [C]	PE	3	3	0	0	3
U15BTE402	Structural Bioinformatics and Computer Aided Drug Design [C]	PE	3	3	0	0	3
U15BTE403	Environmental Biotechnology Risk and Impact Assessment [D]	PE	3	3	0	0	3
U15BTE404	Biofuels Engineering [D]	PE	3	3	0	0	3
U15BTE405	Green Technologies in Biotechnology [D]	PE	3	3	0	0	3
U15GST004	Operations Research*	PE	3	3	0	0	3
U15GST005	Engineering Economics and Financial Management	PE	3	3	0	0	3

A- Track A: Agriculture/Food technology
B- Track B: Biomedical science & technology
C- Track C: Applied Biotechnology
D- Track D: Energy & Environmental Biotechnology
* - for electives I, II and III students can opt out of either Track A or B and take these non-track courses

OPEN ELECTIVES TO STUDENTS OF OTHER DEPARTMENTS							
U15BTOE01	Biology for Engineering	5	OE	3	3	0	0
U15BTOE02	Bioinformatics for Engineering	5	OE	3	3	0	0
U15BTOE03	Intellectual Property Rights	6	OE	3	3	0	0
U15BTOE04	Basic Physiology for Engineering	6	OE	3	3	0	0
U15BTOE05	Enzymes for Textile Processing	7	OE	3	3	0	0
U15GST003	Principles of Management*	PE	3	3	0	0	3

ONE CREDIT INDUSTRY ORIENTED COURSES							
U15BTIN001	Dairy Technology	5/6/7	IN	2	2	0	0
U15BTIN002	Mushroom technology	5/6/7	IN	2	2	0	0
U15BTIN003	Pilot Plant and Industrial Fermentors	5/6/7	IN	2	2	0	0
U15BTIN004	Bioethanol Technology	5/6/7	IN	2	2	0	0

* 5^{th}, 6^{th} or 7^{th} semesters

SEMESTER III

U15MAT308	PROBABILITY AND BIOSTATISTICS	L	T	P	C
		3	1	0	4

Course Outcomes:
At the end of the course student will be able to:

CO1: Compute measures of central tendencies, dispersions and correlate the variables.
CO2: Analyze random or unpredictable experiments and investigate important features of random experiments.
CO3: Construct probabilistic models for observed phenomena through distributions which play an important role in many engineering applications.
CO4: Analyze sample data and interpret the same for population.
CO5: Analyze the data when the sampling distribution is unknown.
CO6: Analyze the experimental designs for one way, two way and three way classified data

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S	S		M					M	M				
CO2	S	S		M					M	M				
CO3	S	S		M					M	M				
CO4	S	S		M					M	M				
CO5	S	S		M					M	M				
CO6	S	S		M					M	M				

Course Assessment methods:			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments, case study	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

OBJECTIVES
For enabling to apply concepts of probability and statistics to biological problems appropriately

Course Content

STATISTICAL MEASURES **9 Hours**

Measures of central tendency: Arithmetic Mean, Median and Mode **–** Measures of variation: Range, Mean deviation, standard deviation and coefficient of variation – Correlation (Discrete Data) – Karl Pearson's Correlation coefficient – Spearman's Rank Correlation – Regression lines (Discrete Data).

PROBABILITY AND RANDOM VARIABLE **9 Hours**

Axioms of probability - Conditional probability – Total probability – Baye's theorem - Random variable – Distribution function – properties – Probability mass function – Probability density function – moments and moment generating function – properties.

STANDARD DISTRIBUTIONS **9 Hours**

Binomial, Poisson and Normal distributions – Moments, Moment Generating functions and properties for the above distributions - Fitting of Binomial and Poisson distributions.

TESTING OF HYPOTHESIS **9 Hours**

Testing of hypothesis for large samples: single mean, difference of means, single proportion, difference of proportions – Small samples tests based on t and F distributions : single mean, difference of means, paired *t*- test and variance ratio test – Chi-square test for independence of attributes and goodness of fit.

NONPARAMETRIC TESTS **3 Hours**

Mann Whitney U test – Kruskal Wallis Test.

DESIGN OF EXPERIMENTS **6 Hours**

Analysis of Variance : Completely Randomized Design – Randomized Block Design – Latin Square Design – Factorial Design : 2^2 design

Total Hours : 60

Theory: 45 Hours **Tutorial: 15 Hours** **Total Hours Covered: 60**

REFERENCES

1. Veerarajan T., Probability, Statistics and Random Processes, Tata McGraw Hill,3rd edition, 2008.
2. Gupta S. P, "Statistical Methods", Sultan Chand & Sons Publishers, 2004.
3. Johnson R. A., "Miller & Freund's Probability and Statistics for Engineers", Sixth Edition, Pearson Education, Delhi, 2000.
4. Gupta.S.C and Kapoor.V.K, Fundamentals of Mathematical Statistics, 11th extensively revised edition, Sultan Chand & Sons, 2007.
5. Walpole R. E., Myers S.L. & Keying Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education Inc, 2002.
6. Wayne W. Daniel, " Biostatistics- A Foundation for Analysis in the Health Sciences", Wiley India, Seventh edition,2007.
7. Veer Bala Rastogi, "Fundamentals of Biostatistics", Ane books Pvt. Ltd, Second edition , 2009.
8. Charles Henry Brase and Corrinne Pellillo Brase "Understandable Statistics", D.C. Heath and Company, Toronto 1987.

U15BTT301	CONCEPTS IN BIOCHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn about the elements of nutrition
- To learn about the metabolism of carbohydrates, lipids, proteins and nucleic acids and their associated disorders
- To learn about the bioenergitic, oxidative phosphorylation and hormonal regulation of metabolism

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 **:** Describe the daily requirement, digestion and absorption of carbohydrates, proteins and lipids.
CO2 **:** Discuss the metabolic pathways of carbohydrates and metabolic disorders associated with item.
CO3 **:** Explain the metabolic pathways of lipids and metabolic disorders associated with item.
CO4 **:** Demonstrate the metabolic pathways of amino acids, nucleic acids and associated disorders.
CO5 **:** Summarize the hormonal regulation of metabolic pathways.
CO6 **:** Illustrate the concepts of bioenergetics and oxidative phosphorylation.

Pre-requisite courses:

1 U15BTT201 Biomolecules and Genetics

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1			S			S								
CO2	S			W								M		
CO3	S			W								M		
CO4	S											M		
CO5	S		M			M								
CO6	S	M												

Course Assessment methods:			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course Content

ELEMENTS OF NUTRITION **6 Hours**

Dietary requirement of carbohydrates, lipids and proteins; Biological value of protein; Concept of protein quality; Protein sparing action of carbohydrates and fats; Essential amino acids; essential fatty acids and their physiological functions. Nutritional importance of carbohydrates, lipids and proteins. Benefits and consequences of consuming polished and unpolished rice. Digestion and absorption of carbohydrates, proteins and lipids.

Case study - Impact of green revolution in Haryana and Punjab on nutrition

12 Hours

METABOLISM OF CARBOHYDRATES AND LIPIDS

Introduction to metabolism; Glycolysis, Gluconeogenesis, Pentose Phosphate pathway.TCA cycle: amphibolic pathway; Glycogenesis and Glycogenolysis; Blood glucose and its regulation; Biosynthesis of fatty acids, Oxidation of fatty acid: beta oxidation and omega oxidation; Biosynthesis of Cholesterol; Biosynthesis of phospholipids and triglycerides. Metabolic disorders of carbohydrate metabolism (pathophysiology, clinical symptoms and treatment): Diabetes mellitus. Metabolic disorders of lipid metabolism: familial hypercholesterolemia.

Case study- Importance of zinc supplementation in diabetes mellitus.

9 Hours

METABOLISM OF PROTEINS AND NUCLEIC ACIDS

Formation of Urea; Biosynthesis and degradation of aliphatic and aromatic amino acids. Biosynthesis of Purines and Pyrimidines; Biodegradation of Purines and Pyrimidines. Metabolic disorders of amino acid metabolism: Phenyl ketonuria, Albinism Metabolic disorders of nucleic acid metabolism: Lesch-Nyhan syndrome, Gout

6 Hours

HORMONAL REGULATION OF METABOLISM

Interconnection of pathways of metabolism. Metabolic regulation: reversible and coupling reactions. Hormonal regulation of glycolysis and gluconeogenesis: insulin, glucagon and glucocorticoids; Hormonal control of glycogenolysis: epinephrine and glucagon; Hormonal control of lipid and protein metabolism.

12 Hours

BIOENERGETICS AND OXIDATIVE PHOSPHORYLATION

Biological oxidation-reduction reactions; redox potentials; High energy phosphate compounds; free energy of hydrolysis of ATP and sugar phosphates. Mitochondrial respiratory complexes; electrochemical gradient; oxidative phosphorylation: chemiosmotic theory; ATP synthase and mechanism of ATP synthesis; photosynthetic electron transport and generation of NADPH & ATP.

Total Hours : 45

Theory: 43 Hours **Case study: 2 Hours** **Total Hours Covered: 45 Hours**

REFERENCES:

1 David L. Nelson and Michael M.Cox (2007). *Lehninger's Principles of Biochemistry*. 4th Edition, New York ,W.H Freeman & Co

2 Lubert Stryer (2003) *Biochemistry*, 5th Edition, New York,W.H Freeman & Co.

3 Sathyanarayana. U (2008)., *Biochemistry*, Kolkata, Books and Allied (P) Ltd.

4 Voet and Voet (2004) *Biochemistry*, 3rd Edition, John Wiley & Sons Inc,

5 Murray, R.K., Granner, B.K., Mayes, A., Rodwell , V.W. (2003) *Harper's Biochemistry*, 29th edition, Prentice Hall International.

6 Mathews, C.K. and van Holde, K.E (2000) *Biochemistry*, 3rd edition, Benjamin / Cummings Publishing Co. Inc.,

7. Dinesh Puri. (2006) *Textbook of Medical Biochemistry*, 2nd edition, Elsevier Publisher.

WEB REFERENCES:

1. http://nptel.ac.in/courses/102105034

2. http://web.expasy.org/pathways

U15BTT302	MICROBIOLOGY	L	T	P	C
		3	0	0	3

Objectives:

- To learn about the microbial world
- To understand different microbes and their morphology and other characteristics.
- To learn about various techniques to control microbes and to apply microbes in allied fields of microbial technology.

Course Outcomes :

At the end of the course student will be able to:

CO1 : Comprehend knowledge about historical perspective of microbiology and its developments

CO2 : Recognize the fundamental concepts in the structure and functioning of a cell
CO3 : Demonstrate the microbial nutritional requirements for growth and metabolism
CO4 : Understand the controlling of microbes using physical and chemical methods
CO5 : Acquire knowledge about industrial and environmental microbial applications
CO6 : Understand the basic knowledge about applied microbiology field

Pre-requisite:
1 U15BTT201 Biomolecules and Genetics

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	W				S									
CO2	M	W		W										
CO3	M	W	W		S									
CO4		S												
CO5		s												S
CO6				W										M

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
		3	Industry survey
3	End semester examination	4	Alumni survey

Course Content

HISTORICAL PERSPECTIVE OF MICROBIOLOGYAND MICROSCOPY 9 Hours
An overview of historical perspective of microbiology: Origin of Leeuwenhoek's Animalcules, Germ theory of fermentation and disease; Classification and Nomenclature of microorganisms; Microscopy – light and electron microscopy; Principles of staining methods to differentiate microbes.

9 Hours

MICROBIAL STRUCTURE AND MULTIPLICATION
Morphology, Structure and Functional anatomy of Prokaryotic and Eukaryotic Cells; Multiplication of bacteria, viruses, algae, protozoa and fungi; Actinomycetes and yeast; Mycoplasma; Bacteriophage.

MICROBIAL NUTRITION, GROWTH AND METABOLISM 9 Hours
Nutritional requirements and Microbiological media; chemical elements as nutrients; different media for culture; Screening and isolation of organisms; Pure culture techniques; Preservation methods; Maintenance of strain improvement; Definition of microbial growth; Cell division; Growth curve in batch culture or closed system; Different methods to quantify bacterial growth; Mathematics of growth: generation time and growth rate constant, factors affecting growth; Microbial metabolism: Entner–Doudoroff pathway, Aerobic and anaerobic respiration.

CONTROL OF MICROORGANISMS AND ANTIMICROBIALS **9 Hours**

Physical and chemical control of microorganisms; Sterilization: Heat sterilization (moist heat, autoclave, dry heat), radiation and filtration; Disinfection: phenol, alcohol and detergents; Chemotherapy and antibiotics: anti-bacterial, anti-fungal agents, anti-viral agents, common mode of actions to control microbes and resistance to antibiotics.

APPLIED MICROBIOLOGICAL APPROACH **9 Hours**

Microorganisms found in food and food spoilage; Microbes as a food and in food production; Clinical microbiology: Collection, transport and processing of clinical samples; Interaction between Microorganisms; Commensalism, Synergism, Mutualism (symbiosis); Lichen symbiosis; food and water borne infections caused by bacteria, virus & protozoa; Interactions among soil microbes.

Theory: 45 Hours **Total Hours : 45**

REFERENCES:

1 Michael J. Pelczar , E.C.S. Chan, *Microbiology* (An Application Based Approach) Tata McGraw Hill; 1st edition, 2010.

2 Talaro, K. P. *Foundations in Microbiology*. 8thEd. NY: McGraw Hill, 2011.

3 Ray, B., Bhuniya, A. Fundamental Food Microbiology, 5th Ed., CRC Press, USA, 2013.

4 Lim D, "*Microbiology*", Second Edition, WCB-McGraw Hill, 2001.

5 Talaron K, Talaron A, Casita, Pelczar and Reid, *Foundations in Microbiology*, W.C.Brown Publishers, 2005.

Other References:

1 http://faculty.washington.edu/korshin/Class-486/MicrobiolTechniques.pdf

2 http://www.microbiologybook.org/

3 http://www.textbookofbacteriology.net/

4 https://www.boundless.com/microbiology/

5 http://nptel.ac.in/courses/102103015/

6 http://www.microbiologytext.com

U15BTT303	STOICHIOMETRY AND FLUID MECHANICS IN BIOPROCESSES	L	T	P	C
		3	1	0	4

Objective(S)

- Make the students to describe the concepts of stoichiometry with relevance to bioprocess engineering
- Make the students to explain the applications of fluid flow operations in bioprocess engineering

Course Outcome(s):

At the end of the course student will be able to:

CO1 : Outline the applications of units and basic chemical calculations involved in bioprocess engineering

CO2 : Discuss the principles of material balances and their applications in bioprocess engineering

CO3 : Explain the principles of thermophysics and their applications in bioprocess engineering
CO4 : Explain the principles of thermochemistry and their applications in bioprocess engineering.
CO5 : Describe the basics of fluid flow and their applications in bioprocess engineering
CO6 : Illustrate the different fluid flow operations and their applications in bioprocess engineering

PRE-REQUISITE(S):
1. U15CHT101 Engineering Chemistry

CO/PO MAPPING
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M													S
CO2	S	S	S						M			M		M
CO3	S	M	S						M			M		
CO4		M							M					
CO5					M		W							S
CO6	M		S		M							S		

COURSE ASSESSMENT METHODS:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

UNITS AND DIMENSIONS **12 Hours**

Units and Dimensions: Introduction, Dimensions and System of units, Fundamental and derived quantities, Unit conversions, Representation of units, Dimensional consistency, Dimensional equations; Basic chemical calculations: Introduction, Composition of solid mixtures, solutions and gaseous mixtures, Ideal gas law and its application, Dalton's law, Amagat's law, Raoult's law, Henry's law.

MATERIAL BALANCES **12 Hours**

Material balances without chemical reactions: Process flow-sheet, Material balances problems, Material balances in distillation towers, extractors, dryers, evaporators, crystallizers and leaching equipments, recycle, bypass and purge streams; Material balances with chemical reactions: Concept of limiting and excess reactants, selectivity, percentage conversion and yield, Fuels and combustion, Stoichiometry of cell growth and product formation.

ENERGY BALANCES **12 Hours**

Thermophysics: Law of conservation of energy, Components of energy balance equations, Heat capacity of solids, liquids, gases and gaseous mixtures, Sensible and latent heat; Thermochemistry: Heat of reaction, Hess's law, Standard heat of formation and combustion, Determination of heat of reaction at temperatures other than standard temperature using specific heat relationships, Energy balances in bioprocess industries.

FLUID MECHANICS **12 Hours**

Fluid statics: Introduction, Nature of fluids, Hydrostatic equilibrium, Manometers, Reynolds experiment and its significance; Basic equations of fluid flow: Continuity equation, Euler's equation and Bernoulli equation; Flow of incompressible fluids in conduits: Hagen-Poiseuille equation; Friction factor and losses: Darcy-Weisbach equation, Applications of fluid flow equations in bioprocess industries.

FLUID FLOW **12 Hours**

Flow measurements: orifice meter, venturimeter, rotameter and Gas flow meters; pumps: classification, principles, construction, working and applications of centrifugal and reciprocating pumps, Pumping of slurries, Flow meters and pumps in bioprocess industries.

Theory: 45 **Tutorial: 15** **Total Hours: 60**

REFERENCE(S):

1. Bhatt, B. I., and Shuchen B. Thakore. *Stoichiometry*. Tata McGraw-Hill Education, 2010.
2. McCabe, Warren Lee, Julian Cleveland Smith, and Peter Harriott. *Unit Operations of Chemical Engineering*. Vol. 5. New York: McGraw-Hill, 1993.
3. Himmelblau, David Mautner, and James B. Riggs. *Basic Principles and Calculations in Chemical Engineering*. FT Press, 2012.
4. Narayanan, K. V., and B. Lakshmikutty. *Stoichiometry and Process Calculations*. PHI Learning Pvt. Ltd., 2006.
5. Coulson, J. M. "Coulson & Richardson's Chemical Engineering Volume 1, Fluid Flow. *Heat Transfer and Mass Transfer*,Butterworth Heinemann.1999
6. Ghosal, Salil K., and Siddhartha Datta. *Introduction to Chemical Engineering*. Tata McGraw-Hill Education, 2011.
7. De Nevers, Noel, and Ragnar Grahn. *Fluid Mechanics for Chemical Engineers*. McGraw-Hill, 1991

OTHER REFERENCE(S):

1. http://nptel.ac.in/courses/113104060/4
2. https://www.coursera.org/learn/fe-exam/supplement/gWyHE/fluid-mechanics

U15BTT305	PRINCIPLES OF BIOORGANIC CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable understanding chemical principles governing biochemical reactions
- To learn synthetic strategies and molecular models of biomolecules

COURSE OUTCOMES :

At the end of the course student will be able to:

CO1 : Recognize role of organic chemistry in biology
CO2 : Explain the chemical reactions of coenzymes
CO3 : Recall the role of animoacids in enzyme catalysis
CO4 : Outline the synthesis of natural products
CO5 : Describe the chemistry of nucleic acids
CO6 : Recall the importance and influence of metal ions on protein function

PRE-REQUISITE(S):

1 U15CHT101 Engineering Chemistry
2 U15CHT206 Chemistry for Biotechnology
3 U15BTT201 Biomolecules and Genetics

CO/PO Mapping
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(Pos)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S			M									W	
CO2				S									W	
CO3		M	M		M									
CO4		S												
CO5					M									
CO6		M			M								W	

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course Content

INTRODUCTION TO BIOORGANIC CHEMISTRY: 9 Hours

Overview of Bioorganic Chemistry- Historical Connection Between Organic and Biological Chemistry; Weak Interactions in Organic and Biological World; Proximity Effect in Organic Chemistry; Molecular Recognition; Chemistry of the Living Cells; Analogy Between Biochemical and Organic Reaction.

BIOORGANIC CHEMISTRY OF ENZYMES: 9 Hours

Coenzymes in catalysis, Mechanism and role of: pyridoxal phosphate aminotransferases), NAD/NADP (dehydrogenases); Thiamine pyrophosphate (carboxylases); Case studies of structure and mechanism- Horse Liver alcohol dehydrogenase, alpha –chymotrypsin; Enzymes in organic transformations- hydrolysis of amide bond, esters; reduction of aldehydes and ketones using enzymes and whole cells; Enzymes in organic solvents- ester, lactone and peptide synthesis; Cyclodextrins

CHEMISTRY OF NATURAL PRODUCTS 9 Hours

Alkaloids: properties and reactions; Synthesis and biological properties of coniine, piperine
Terpenoids and Carotenoids: General methods of synthesis of terpeniods; Isoprene rule; Structure and synthesis of menthol; General methods of Anthocyanines and flavones synthesis;
Cyanidine chloride and Quercetin; Curcumin, structure and synthesis

BIOORGANIC CHEMISTRY OF NUCLEIC ACIDS: 6 Hours

History, Sugars and bases; Conformation of sugar-phosphate backbone; hydrogen bonding by bases; the double helix; A, B, and Z double helices; Stability of Double Helix ; DNA intercalators;
Chemical synthesis of DNA; Catalytic RNA, siRNA; micro RNA; Fluorescently Labeled Nucleosides and oligonucleotide probes; Homogeneous DNA Detection; Microarray based DNA Detection;

METAL-LIGAND COMPLEXES IN PROTEINS 9 Hours

Transition metal ions and oxidation states; Coordinate bonds in proteins and ligands; Types of ligands; Role of iron in Myoglobin, Haemoglobin and cytochromes; Copper in Hemocyanin;
Magnesium in chlorophyll; Cobalt in vitamin B-12 and Molybdenum in nitrogenase; Role of important Metaloenzymes; Geometrical and optical isomerism in coordination complexes

Theory: 45 Hours Total Hours :45

REFERENCES:

1 Hermann Dugas: Bioorganic Chemistry-A chemical Approach to Enzyme Action; 3rd Edition.

2 The organic chemistry of enzyme-catalyzed reactions, by Richard B. Silverman, Academic Press, San Diego, 2000, 717 pp.

3 Kalsi.P.S and Jagtap.S *Pharmaceutical, Medicinal and Natural Product Chemistry*, Narosa Publishing house, New Delhi, 2013

4 Biochemistry, 5th Ed. (Hardcover) by Lubert Stryer, Jeremy M. Berg, and John L. Tymoczko.

5 Amino acids, peptides and proteins, by J. S. Davies, Royal Society of Chemistry, UK, Vol. 35, 2006.

6 John McMuray, 2nd edition., *Organic Chemistry with biological applications*, Texas,

Thomson Brooks/Cole. 2011.

OTHER REFERENCES:

1 H. Dugas, H. *Bioorganic Chemistry*, Berlin: Springer Verlag. 1999.
2 Dobson, C. M., Gerrard J. A, Pratt, A. J. *Foundations of Chemical Biology*, USA: Oxford University Press, 1995.
3 http://nptel.ac.in/courses/104103018/1
4 http://www.saylor.org/courses/chem204/

U15GST006	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

Objectives:

- Acquire knowledge on the various stages of a product development process
- Develop skills for using the various tools and techniques for developing products
- Acquire knowledge on project management techniques

Course Outcomes(COs)

At the end of the course student will be able to:

CO1: Understand the process to plan and develop products
CO2: Understand the process of collecting information and developing product specifications
CO3: Understand the concept generation, selection and testing processes
CO4: Understand the concepts of product architecture, industrial design and design for manufacture
CO5: Understand the basics of prototyping, economic analysis
CO6: Understand the concepts of project planning and execution processes

Pre-requisite:

1. Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1			M								S			
CO2			M								M			
CO3			S											
CO4			M											
CO5			S						M	M	S			

CO6			S						M	M				

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS - PRODUCT PLANNING **9 Hours**

Characteristics of successful product development to design and develop products, duration and cost of product development, the challenges of product development. A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre-project planning, reflect all the results and the process.

IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS **9 Hours**

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process; specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING **9 Hours**

The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process. Overview of methodology, concept screening, concept scoring, caveats.

Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

PRODUCT ARCHITECTURE - INDUSTRIAL DESIGN - DESIGN FOR MANUFACTURING **9 Hours**

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design. Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING - PRODUCT DEVELOPMENT ECONOMICS - MANAGING PROJECTS **9 Hours**

Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

Theory: 45 Hours **Total Hours: 45**

REFERENCE BOOKS:

1. Product Design and Development: Karl. T. Ulrich, Steven D Eppinger,. Irwin McGrawHill.
2. Product Design and Manufacturing: A C Chitale and R C Gupta, PHI
3. New Product Development: Timjones. Butterworth Heinmann,, Oxford. UCI.
4. Product Design for Manufacture and Assembly: Geoffery Boothroyd, Peter Dewhurst and Winston Knight.

U15BTP301	BIOCHEMISTRY & BIOORGANIC CHEMISTRY LAB	L	T	P	C
		0	0	4	2

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 **:** Demonstrate isolation of biomolecules from plant tissues and carry out analysis
CO2 **:** Demonstrate isolation of macromolecules from animal tissue and carry out analysis
CO3 **:** Perform enzymatic analysis of amylase from saliva to determine its activity
CO4 **:** Execute synthesis of bioactive molecules
CO5 **:** Perform preparation of biodiesel
CO6 **:** Draw molecular structures of simple molecules

Pre-requisite(s):

1 U15BTP201 Biomolecules and Genetics Lab

CO/PO Mapping S-Strong, M-Medium, W-Weak														
Cos	**Programme Outc omes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSPO1**	**PSPO2**
CO1	S	W		M					S				M	
CO2	S	W		M									W	
CO3				M					S					
CO4		W		M					S					M
CO5		W		M										S
CO6		W		M	S									

Course Assessment methods:

Direct	**Indirect**
1 Continuous Assessments	**1** Course end survey
2 Model Practical Examinations or Internal	**2** Faculty survey
3 End semester Practical Examination	**3** Industry survey
	4 Alumni survey

Course Content

I. BIOCHEMISTRY

1. Isolation and estimation of biomolecules from natural sources:
2. Total carbohydrate by Anthrone method
3. Reducing sugars by DNS method
4. Proteins from by Lowry/Bradford method
5. Amino acids by Ninhydrin method
6. Cholesterol by Zak's method
7. Ascorbic acid by DNPH method

II. BIOORGANIC CHEMISTRY

1. Synthesis of aspirin
2. Extraction of lycopene from tomato paste
3. Extraction of caffeine from tea
4. Biodiesel preparation
5. Saponification reactions of vegetable oils
6. Chemical structure drawing and structure analysis using molecular modeling tools

Total Hours : 45

Theory: Nil **Practicals: 45 Hours** **Total Hours Covered: 45**

REFERENCES:

1 Sadasivam.S and Manickam.A (2005), *Biochemical methods*, 3rd edition, New Age International

(P) Limited Publisher, New Delhi.
2 David T.Plummer (1987). *An Introduction to Practical Biochemistry*, 3rd edition, London; New York: McGraw-Hill,.
3 Irwin H.Siegel (2014). Biochemical calculations, 2nd edition, John Wiley & Sons, London.
4 Vogel A.I. and Tatchell A.R. (2004). Vogel's *Text book of Practical Organic Chemistry*. 5th Edition..
5. Shanmugam S. , Kumar, T. Sathish , Paneerselvam,K (2010). Laboratory Handbook on Biochemistry, Prentice-Hall of India Pvt.Ltd

U15BTP302	MICROBIOLOGY LABORATORY	L	T	P	C
		0	0	4	2

Objective(s):

- To understand and learn the basic techniques applicable for the biotech industry

Course Outcomes :

At the end of the course student will be able to:

CO1 **:** Understand and demonstrate the working principles, procedures of microbiology lab experiments and equipment
CO2 **:** Observe and practice different types of culture media and broth for microbial cultivation
CO3 **:** Differentiate microbes using staining methods
CO4 **:** Estimate and evaluate the microbial screening, identification and characterization
CO5 **:** Understand how to cultivate anaerobic culture under CO environment
CO6 **:** Evaluate commercial antibiotics efficacy against bacterial species isolated to confirm the susceptibility

Pre-requisite:

1 U15BTP201 Biomolecules and Genetics Laboratory

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	W				S								W	
CO2	M	W		W									W	
CO3	M	W	W		S									
CO4		S												
CO5			M											

CO6				S									S	

Course Assessment methods:

Direct		Indirect	
1	Internal practical test I & II	**1**	Course end survey
2	End semester practical examination	**2**	Faculty survey
		3	Industry survey
		4	Alumni survey

Course Content

1 Handling of Compound Microscope, Autoclave, Hot air oven, Laminar Airflow
2 Preparation of media: Nutrient broth, Nutrient agar, slants, soft agar
3 Pure culture technique: Serial dilutions, Pour plate, Spread plate and Streak plate.
4 Measurement of microbial Size: Micrometry Test
5 Quantification of microorganisms by; Turbidimetry and Nephelometry (McFarland standards)
6 Motility determination : Hanging drop method and Agar gel Stabbing Method
7 Enumeration of bacterial / yeast cells: Direct and Indirect methods (Haemocytometer & Total viable counts).
8 Staining methods: Simple, Gram staining, Negative, Spore, Flagella, Capsule and Acid fast
9 Staining of fungus: Lacto phenol cotton blue staining.
10 Growth curve: Determination of growth rate and generation time.
11 Anaerobic Cultivation : Fluid Thioglycolate broth and Anaerobic jar methods
12 Antibiotic sensitivity assay: Disc and Well diffusion method

Theory: Nil **Total Hours : 45**

REFERENCES:

1 Paul A. Ketchum Microbiology – Concepts and application, Wiley Publications, USA, (2001)
2 T.Palvannan, S.Shanmugam and T.Sathish Kumar Lab Manual on Biochemistry, Bioprocess & Microbiology- Scitech Publishers, Chennai, (2005)
3 Barry Chess, Laboratory Applications in Microbiology: A Case Study Approach, 3e, 2015
4 Alfred Brown and Heidi Smith, Benson's Microbiological Applications, 13e, 2014
5 Steven Obenauf and Susan Finazzo, Laboratory Manual for Microbiology Fundamentals: A Clinical Approach, 2nd Edition, 2015.
6 Joseph MC farland, M.D.Jama.The nephelometer: an instrument for estimating the number of bacteria in suspensions used for calculating the opsonic index and for vaccines. 1907; (14):1176-1178

OTHER REFERENCES:

1 http://www.uwyo.edu/virtual_edge/home.htm
2 http://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/ucm114664.htm
3 https://www.mountsinai.on.ca/education/staff-professionals/microbiology
4 http://highered.mheducation.com/sites/007352252x/student_view0/virtual_labs.html
5 http://learn.chm.msu.edu/vibl/index.html

U15GHP301/ FAMILY VALUES	L	T	P	C
(Common to all branches of Engineering and Technology)	**1**	**0**	**0**	**1**

Objectives

1. To understand the importance of family and to contribute to it
2. To spiritual development through good family life.
3. To respect womanhood
4. To lead a healthy and disease free life

Course outcomes:

At the end of the course student will be able to:

1. The students shall understand the importance of a family
2. The students shall acquire skills in simplified Kundalini yoga for sound health.
3. The students shall learn about greatness of womanhood
4. The students shall learn about the importance of Blessings and relationship
5. The students shall know about simplified Kundalini yoga, its methodology and its benefits

Pre-requisite: NIL

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1						M		M	S	W		M		
CO2						S	M		W			S		
CO3						W						M		
CO4						M			M			S		
CO5						M						M		

Course Assessment methods:

Direct	Indirect
1.Individual Assignment 2.Group Assignment 3.Presentation 4.Surprise Test 5.Practical Assessment 6.End Semester Assessment	1.Attendance and Behavioural Assessment

Introduction to Family Life – An Overall Perspective	1 Periods
Personal & Spiritual development through good Family life	1 Periods
Importance of Relationships & Blessings	3 Periods
Food as Medicine – Quantum Healing	3 Periods
Greatness of womanhood	2 Periods
Simplified Physical Exercises (Kundalini Exercises)	5 Periods

Total Periods: 15

References Books:

1. Vethathiri's Maharishi's, *"Yoga for Modern Age"*, The World Community Service Centre, Vedhathiri Publications, 2009.
2. Swami Vivekananda, "*The Man Making Message***"** The Ramakrishna Tapovanam, Published 1972.
3. Vethathiri's Maharishi's**,** *"Manavalakalai part 1,2&3"* 1^{1th} edition, The World Community Service Centre, Vethathiri Publications,2005.
4. Brian L Weiss, **"** *Only Love is Real* " by Grand Central Publishing, Published 1997.

SEMESTER IV

U15EST006	BASIC CONCEPTS IN ENVIRONMENTAL SCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources
- Know what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity
- Identify the major challenges in environmental issues and evaluate possible solutions

COURSE OUTCOMES:

At the end of the course student will be able to:

CO1 : Analyze the impact of engineering solutions in a global and societal context
CO2 : Discuss contemporary issues that results in environmental degradation and would attempt to provide solutions to overcome those problems using Environmental Biotechnology
CO3 : Highlight the importance of ecosystem and biodiversity
CO4 : Ability to consider issues of environment and sustainable development in his personal and professional undertakings
CO5 : Paraphrase the importance of conservation of resources.
CO6 : Play an important role in transferring a healthy environment for future generations

Pre-requisite: Nil

CO/PO Mapping
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)													
	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO12	PSPO1	PSPO2
CO1	S	M					S							S
CO2						S	S							M
CO3							M			M				S
CO4							M	W				M		S
CO5						M	M			S				M
CO6						M	S							S

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
		3	Industry survey
3	End semester examination	**4**	Alumni survey

Course Content

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES **14 Hours**

Definition, scope and importance; Need for public awareness; Forest resources: Use and over-exploitation, deforestation, case studies; Timber extraction; mining; dams and their effects on forests and tribal people. Water resources: Use and overutilization of surface and ground water; conflicts over water; dams: benefits and problems; water conservation; rainwater harvesting; watershed management. Mineral resources: Use and exploitation; environmental effects of extracting and using mineral resources; case studies. Food resources: World food problems; changes caused by agriculture and overgrazing; effects of modern agriculture; fertilizer-pesticide problems; biofertilizers and biopesticides; case studies. Energy resources: Growing energy needs; urban problems related to energy; renewable and non-renewable energy sources; use of alternative energy sources; case studies. Land resources: Land as a re

source; land degradation; man induced landslides; soil erosion and desertification; wasteland reclamation; role of an individual in conservation of natural resources.

ECOSYSTEMS AND ECOSYSTEM BIODIVERSITY: **9 Hours**

Concept of an ecosystem; structure and function of an ecosystem: Producers, consumers and decomposers; food chain; food web; energy flow in the ecosystem; ecological pyramids; ecological succession; introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

BIODIVERSITY: **9 Hours**

Introduction to biodiversity; definition: Genetic, species and ecosystem diversity; population viability analysis: Hardy-Weinberg equilibrium; Gaia Hypothesis; Biogeographical classification of India; value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic values; India as a mega-diversity nation; Hot-spots of biodiversity; threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION **10 Hours**

Definition, causes, effects and contributions of Biotechnology to control (a) air pollution (b)

water pollution (c) marine pollution (d) nuclear hazards; Role of an individual in prevention of pollution; pollution case studies; contributions of Biotechnology to environmental management of solid and hazardous wastes; biomedical waste; biodegradation of organic pollutants; concepts in bioremediation; waste minimization; disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES, HUMAN POPULATION AND THE ENVIRONMENT 7 Hours

From unsustainable to sustainable development; resettlement and rehabilitation of people, its problems and concerns; case studies; issues and possible solutions: Climate change, global warming, acid rain, ozone layer depletion; Environmental Impact Assessment (EIA); Environmental Impact Statement (EIS);Environment Protection Act (EPA); Air (Prevention and Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislations; Human Rights.

ENVIRONMENTAL BIOTECHNOLOGY 5Hours

Population growth and explosion; age structure; women and child welfare programme; environment and human health; communicable diseases; role of information technology in environment and human health; case studies.

Theory: 45 hours **Total hours: 45**

REFERENCES:

1 Miller, George Tyler. "Environmental science: An introduction." (1985).

2 Masters, Gilbert M., and Wendell Ela. *Introduction to environmental engineering and science*. Vol. 3. Englewood Cliffs, NJ: Prentice Hall, 2008. Accession No. 22359

3 Bharucha, Erach. *The Biodiversity of India*. Vol. 1. Mapin Publishing Pvt Ltd, 2002.Accession No. 44027

4 Trivedi R.K., *Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards*, Vol. I and II, Enviro Media. 1996.

5 Townsend, Colin R., Michael Begon, and John L. Harper. *Essentials of ecology*. No. Ed. 2. Blackwell Science, 2003. Accession No. 31817.

6 McCarty, Perry L. *Environmental biotechnology: principles and applications*. Tata McGraw-Hill Education, 2012. Accession No. 74100.

OTHER REFERENCES:

1 http://nptel.ac.in/course.php?disciplineId=120

2 nptel.ac.in/courses/120108004/

U15CSP202 **PROBLEM SOLVING TECHNIQUES**

L	T	P	C
1	0	2	2

Course Objectives:

To introduce students to the foundations of computing, programming and problem-solving.

To develop basic programming skills necessary for engineering education.

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1	Write a pseudo code for the identified problem	S
CO2	Translate the pseudo code into an executable program	S
CO3	Validate the program for all the possible inputs.	S
CO4	Identify an appropriate approach to solve the problem	S
CO5	Use different data structures	S

Pre-requisite: Nil

CO/PO Mapping
(S/M/L indicates strength of correlation) S-Strong, M-Medium, L- Low

COs	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	M		M					L						
CO2	S	M		M	S				L						
CO3	S	M		M					L						
CO4	S	M		M					L						
CO5	S	M		M					L						

Course Assessment Methods:

Direct	Indirect
• Model Lab Exam • End Semester Practical Exam	• Course Exit Survey

Course Content:

Problem solving

General problem solving concepts, approaches and challenges, problem solving with computers, data structures

Approaches

Solve by analogy, Decompose the task into smaller subtasks, Building block approach, merging solutions, Algorithmic thinking, Choice of appropriate data structures, Implementation of the Pseudo-

code, implementing the code, testing the solution

Introduction to program structure

Variables and constants, local and global variables, expressions, control structures, selection structures, arithmetic, relational and logical operators, Conditional and looping statements, programming in manageable pieces: program modules, subprograms, functions and recursion

Problem to code approach

Problem statement, problem analysis, program design, program code, program test

Sorting (Numbers and Strings)

Bubble sort, Insertion sort, Selection Sort

Searching (Numbers and Strings)

Binary search, Random search, Search for Max-Min

References:

1. *R. J. Dromey, How to solve it by Computer, Prentice Hall International, New Jersey, 2007*
2. *Harold Abelson and Gerald Sussman, Structure and Interpretation of Computer Programs, MIT Press, 1996.*
3. *Subhasis Banerjee, S. Arun Kumar, D. Dubhashi, Introduction to Computer Science, McGraw Hill India.*

List of Experiments:

I **Problems based on Numbers:**

1) Write a program to compute the factorial of a given number.

Test Case	**1**	**2**	**3**	**4**
Input	8	1	0	-5
Output	40320	1	1	Invalid

2) Write a program to find all numbers between 2000 and 3000 (both inclusive) which are divisible by 7 but not a multiple of 5. All such numbers are to be printed in a comma separated sequence on a single line.
Output: 2002, 2009, 2016, … 3199

II **Problems based on Data Processing:**

1) Write a program that takes an IP address of the form P.Q.R.S as input, where P, Q, R and S are decimal numbers in the range 0 to 255, and prints the class of the address as indicated in the table below.

Value of P	**Class**
1 – 126	A
128 – 191	B
192 – 223	C
224 – 239	D
240 – 254	E

Test	**1**	**2**	**3**	**4**	**5**

Case					
Input	224.220.206.91	126.220.206.91	127.0.0.1	0.100.100.100	255.255.255.255
Output	Class D	Class A	Invalid	Invalid	Invalid

2) Write a program to check if a given number is a stepping number or not.
Note: A number is called a stepping number if every adjacent digit, except those separated by commas, differs by 1. A stepping number can't be a 1-digit number; it must be at least a 2-digit number. For example 45 and 43,545 are valid stepping numbers, but 890,098 is not a stepping number because the difference between numbers 9 and 0 cannot be considered as 1.

Test Case	1	2	3	4	5
Input	567	89,432	780,023	7	49
Output	Valid	Valid	Invalid	Invalid	Invalid

3) Write a program that takes a large English text file as input and counts the number of occurrences of each alphabet in the text.
(i) Display the alphabet with maximum and minimum number of occurrences.
(ii) Swap the alphabets with maximum and minimum occurrences to obtain a modified text file.
(iii)Take the output of (ii) as input and get back the original text file.

Test case:
Input: A text file with 3000 characters - in which 500 are e and 5 are z.
Output: (i) Maximum occurrence – e and Minimum occurrence – z
(ii) The characters e and z in the text file are swapped to get a modified text
(iii) The original text file

4) The property of Exclusive OR operation (i) Any X $\oplus$ X is 0 (ii) Any X $\oplus$ 0 is X. An Encryption and Decryption scheme using this property is given below:
Encryption Algorithm: Cipher Text (C) = Plain Text (P) $\oplus$ Key (K)
Decryption Algorithm: Plaint Text (P) = Cipher Text (C) $\oplus$ Key (K)
Answer the following questions:
(i) For any given P and the corresponding C, find K [K = P $\oplus$ C]
(ii) For any given C and the corresponding key K, find P [P = C $\oplus$ K]

Test Case		1	2	3
Input	P	1 1 0 0 1 1 0 0	0 0 1 1 1 1 0 0	1 1 1 1 1 1 1 1
	C	0 0 1 1 0 0 1 1	1 0 1 0 1 0 1 1	1 1 1 1 1 1 1 1
Out	Key	1 1 1 1 1 1 1 1	1 0 0 1 0 1 1	0 0 0 0 0 0 0 0

put			1	
	New cipher text	0 0 0 0 0 0 0 0	1 1 0 0 1 1 1 1	11 11 1 1 1 1
	Plaintext (New cipher text ⊕Key)	1 1 1 1 1 1 1	0 1 0 1 1 0 0 0	1 1 1 1 1 1 1 1

5) Write a function num_atoms( ) that takes the weight of the element in grams and its atomic weight as parameters and calculates the number of atoms in n grams of an element.

Note: Atomic weight of gold (Au) 196.97 with units in grams/mole.

Atomic weight of carbon=12.001, Atomic weight of hydrogen=1.008

Avogadro's number is a constant, 6.022×10^{23}

Test Case 1:

Amount of gold =4.5grams, n = 0.45/197 = 2.28×10^{-3} , 1 mol = 6.022×10^{23} atoms

Total number of atoms =$6.022 \times 10^{23} \times 2.28 \times 10^{-3} = 13.756 \times 10^{20}$

6) Define a procedure histogram() that takes a list of integers and prints a histogram to the screen.

Test Case	**1**	**2**	**3**
Input	histogram([4])	histogram([-3, 6, 12])	histogram([2, 0, 3])
Output	****	****** **********	** ***

7) Write a program to solve this classic ancient Chinese puzzle: We count 35 heads and 94 legs among the chickens and rabbits in a farm. How many rabbits and how many chickens do we have?

8) In cryptography, a Caesar Cipher is a very simple encryption technique in which each letter in the plain text is replaced by a letter some fixed number of positions down the alphabet. For example, with a shift of 3, A would be replaced by D, B would become E, and so on. ROT-13 ("rotate by 13 places") is a widely used example of a Caesar cipher where the shift is 13. Write a program to implement an encoder/decoder of ROT-13.

Test Case	**1**	**2**
Input	Roy eats	Deer stays back
Output	Ebl rngf	Qrre fgnlf onpx

9) Newton's Second Law of motion is expressed as $F = m \times a$, where F is force, m is mass and a is acceleration. Write a program to calculate the acceleration if mass of an object and the force on that object are given as input. Display the result to the user.

Test Case	**1**	**2**

Input	Mass=5, Force =1050	Mass =3, Force=564
Output	210	188

III **Problems based on Strings and Functions:**

1) Write a program (using functions) that takes a long sentence with multiple words as input and rearranges the words in the sentence in the reverse order.

Test Case	**1**	**2**	**3**
Input	My name is python	Kumaraguru College of Technology	Problem based on Strings
Output	python is name My	Technology of College Kumaraguru	Strings on based Problem

2) Write a program that accepts a sequence of 4 digit binary numbers as its input, which are comma separated and prints as output, only the binary numbers that are divisible by 5 in the same format.

Test Case	**1**	**2**	**3**
Input	0100,0011,1010,1001,1100,1001,0101	0010, 1111, 1100	1110, 1000, 1110
Output	1010, 0101	1111	Not divisible by 5

3) Write a program that accepts a sentence as input and calculates the number of letters, digits and special characters.

Test Case		**1**	**2**
Input sentence		hello world! @$ 123	There is a laptop with #CS123…
Output	Letters	10	20
	Digits	3	3
	Special Characters	3	4

4) Write a String tokenizer program that accepts a file as input and counts the number of lines and words and prints the same as output. (Note: You can use wc command also)

Test Case	**Input Sentences**	**No. of lines**	**No. of words**
1	Correctness and efficiency issues in programming, time and space measures Basics of imperative style programming Assertions and loop invariants	3	19

2	greedy algorithms are not always the optimal process, even after adjusting the order of their processing	2	16

5) Write a "space_correction()" function that takes a string (sentence) as input and examines it for space characters. If there are two or more continuous space characters in the sentence then they are deleted, so as to have only one space character between words. It also examines the end of sentences; if the period (full stop) is directly then followed by a letter it inserts a space after the period.

Test case I	Input	space_correction(“This is very funny and cool.Indeed!")
	Output	"This is very funny and cool. Indeed!"
Test case II	Input	space_correction(“A flow chart provides appropriate steps to be followed.it is a program design tool”)
	Output	A flow chart provides appropriate steps to be followed. it is a program design tool

6) Write a function printValue() that can accept two strings as input and prints the longer of the two. If two strings have the same length, then the function should print both the strings.

Test case	**1**	**2**	**3**
Input	printValue(“one”,”three”)	printValue(“laptop”,”laptop”)	printValue(“ten”,”so”)
Output	three	laptop laptop	ten

7) An anagram is a type of word play, the result of rearranging the letters of a word, using all the letters in the original word exactly once; e.g., uleb = blue. Write a program that accepts the jumbled characters from user and choose the correct word from the given list by rearranging the characters in the word. Display the word, if it is available in the given list of word. Assume that the list of words is set of colors like {brown, blue, green etc}

Test case	**1**	**2**	**3**
Input	onwbr	reegn	etihw
Output	brown	green	white

8) Assuming that we have some email address of the form "username@companyname.com". Write a program to print the user name of a given email address. Both user names and company names consists of letters only.

Test case	**1**	**2**
Input	inboxcse@gmail.com	csedeptgroups#yahoomail.com
Output	inboxcse	Invalid email address

9) Write a program that takes a string as input and prints the number of occurrences

of each character in the string.

Test case	**1**	**2**
Input	abbaca	icici
No. of occurrences	a=3,b=2,c=1	i-3 , c-2

10) Write a recursive function and an iterative function to compute the Fibonacci sequence. Compare the performance of both functions.
11) Write a version of a palindrome recognizer that also accepts phrase palindromes such as "Go hang a salami I'm a lasagna hog.". (Note: punctuation, capitalization and spacing are ignored)

Test case	**1**	**2**
Input	i am tired	was it a rat i saw
Output	Not a palindrome	Palindrome

12) In English, a sentence using present continuous is formed by adding the suffix -*ing* to the verb.(example: go→ going).

A simple set of heuristic rules can be given as follows:

1. If the verb ends in *e*, drop the *e* and add *ing* (if not exception: be, see, knee, etc.)
2. If the verb ends in *ie*, change *ie* to *y* and add *ing*
3. For words consisting of consonant-vowel-consonant, double the final letter before adding *ing*
4. By default, just add *ing*

Write a function "make_ing_form()" which converts a given verb to present continuous form. Test your function with words such as lie, see, move and hug.

Test case	**1**	**2**	**3**	**4**
Input	believe	tie	sit	walk
Output	believing	tying	sitting	walking

13) A pangram is a sentence that contains all the letters of the English alphabet at least once. Write a function to check if a given sentence is a pangram or not. If the given sentence is not a pangram print the missing letters.

Test case	**1**	**2**
Input	*The quick brown fox jumps over the lazy dog*	*The quick brown rat jumps over the lazy cat*
Output	Pangram	Not a Pangram Missing letters*:f,x,d,g*

14) Write a function "calc_weight_ on_ planet()" that takes two arguments - weight on Earth and the surface gravity of the other planet and calculates the equivalent weight on the other planet. (Note: The surface gravity of Jupiter is 23.1 m/s^2

(approx) and that of Earth is 9.8 m/s^2(approx), Weight = Mass x Surface gravity)

Test case	**1**	**2**
Weight on Earth(lb)	*127.2*	*-100*
Weight on Jupiter	297.6	*Invalid*

15) Write a program to check the validity of passwords entered by users.
Following are the criteria for a valid password:
1. At least 1 letter between [a-z]
2. At least 1 letter between [A-Z]
3. At least 1 number between [0-9]
4. At least 1 character from [$#@]
5. Minimum length of password: 6
6. Maximum length of password: 12

Your program should accept a sequence of passwords that are comma separated and check them for validity based on the criteria given above and print the valid passwords only in the comma separated form.

Test case	**1**	**2**	**3**
Input	ABd1234@1, a F1#,2w3E*,2We3345	HFd1244@1, a F1#,2w3E*,2We334#5	ABd12342, a F1#,2w2B*,2We3345
Output	ABd1234@1	HFd1244@1, 2We334#5	Invalid

V **Problems based on Data Structures:**

1) Write a program that maps a list of words to a list of integers (representing the lengths of the corresponding words). Write it in three different ways: 1) using a for-loop, 2) using the higher order function map (), and 3) using list comprehensions

2) Write a program that prompts the user to enter the name of the fruit and its weight. The program should then display the information in the same form but in the alphabetical order.

Test case	**1**	**2**	**3**
Input	Kiwi, 4 kg, Apple, 6 kg, Banana, 11 kg	Gowva, 4 kg, Apple, 6 kg, Banana, 11 kg	Carrot, 4 kg, Kiwi, 6 kg, Banana, 11 kg
Output	Apple, 6 kg, Banana, 11 kg, Kiwi, 4 kg	Apple, 6 kg, Banana, 11 kg, Gowva, 4 kg	Banana, 11 kg, Carrot, 4 kg, Kiwi, 6 kg

3) Write a program that prompts the user to enter a list of words and stores them in a list. Create a new list that retrieves words from the first list such that first letter occurs again within the word. The program should display the resulting list.

Test case	**1**	**2**

Input	Baboon, List, Duplicate	Frog, Snake, Lizard
Output	Baboon	No Such word exist in list

4) List Overlap Solution:
Consider the following lists, A = [1,1,2,3,5,8,13,21,34,55,89] &
B = [1,2,3,4,5,6,7,8,9,10,11,12,13]
Write a program that returns a list that contains only the elements that are common between the lists (without duplicates). Make sure your program works on two lists of different sizes.
Hint: (A intersection B)

Test cases:
Input the following lists,
A = [1,1,2,3,5,8,13,21,34,55,89] B = [1,2,3,4,5,6,7,8,9,10,11,12,13]
Output: A ∩ B= [1,2,3,5,8,13]

VI Problems based on Sorting:

1) Write a program to sort the (name, age, score) tuples in ascending order where name is string, age and score are numbers. The tuples are input using the console. The sort criteria are:
   a. Sort based on name
   b. Then sort based on age;
   c. Then sort by score
   d.

Test case	**1**	**2**
Input	Tom,19,80 John,20,90 Jony,17,91	Jony,17,91 Jony,17,93 Json,21,85
Output	[('John', '20', '90'), ('Jony', '17', '91'), ('Jony', '17', '93'),('Tom', '19', '80')]	[('Jony', '17', '91'), ('Jony', '17', '93'), ('Json', '21', '85')]

2) Write a program that accepts a sequence of words that are hyphen separated as input and prints the words in a hyphen-separated sequence after sorting them alphabetically.

Test case	**1**	**2**	**3**
Input	green-red-yellow-black-white	red-yellow-black	green-yellow-white
Output	black-green-red-white-yellow	black -red-yellow	green-white-yellow

VII **Problems based on Divide and Conquer:**

1) Write a program for binary search using arrays

Test case	**1**	**2**
Input	4, 7,8,11,21	4, 7,8,11,21
Enter the number to be search	11	18
Output	The number is present	The number is not present

VIII **Problem Solving by Backtracking:**

1) Write a program to solve the 4-Queen's Problem.

Total Hours:24

U15BTT402	**BIOTECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Objectives:

- To provide the students an ability to understand the principles of instrumentation and biotechnology oriented techniques
- To enable students understand the applications of techniques in the field of biology

Course Outcomes :

At the end of the course student will be able to:

CO1 : Explain the basics of measurements and different extraction methodologies, and their applications in biotechnology

CO2 : Describe the instrumentation and applications of specialized molecular spectroscopic techniques

CO3 : Demonstrate the principles and techniques of chromatography, and electro-analytical methods and their applications in biotechnology

CO4 : Explain the various electrophoretic and thermal techniques and their applications in biotechnology

CO5 : Distinguish and interpret the various structural elucidation methods

CO6 : Describe the basics of radiation and radioisotope methods

Pre-requisite:

1 U15CHT101 Engineering Chemistry
2 U15BTT201 Biomolecules and Genetics
3 U15MAT305 Probability and Biostatistics

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PO12	PSPO1	PSPO2
CO1	S	M	W	M		W				M		W		W
CO2	S	W	M											
CO3			M											M
CO4			M							M				M
CO5			S	S								M		M
CO6		M	W			M				M				M

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course Content

MEASUREMENT BASICS AND EXTRACTION METHODS 9 Hours
Classification of instrumental methods; Concepts of accuracy, precision and limits of detection (LOD); Types of errors: random and systematic; Calibration of instrumental methods: comparison with standards, external and internal standard addition methods; Introduction and significance of signal to noise ratio (S/N); Solvent extraction: introduction and principle; Extraction techniques: batch, stripping or back, continuous and counter-current-current; Principle of solid extraction (Soxhlet); Types: Temperature assisted, pressurized hot water and supercritical fluids based extraction.

SPECTROSCOPIC TECHNIQUES 9 Hours
Flame photometry; nephelometry; spectrofluorimetry; circular dichroism (CD); UV-Visible; Infrared (IR); FT-IR, and Raman Spectroscopy: principle, instrumentation and applications.

CHROMATOGRAPHY AND ELECTROANALYTICAL METHODS 9 Hours
Factors affecting the resolution of chromatography; Rate and plate theory; Significance of VanDeemter equation; Thin layer chromatography; Supercritical fluid chromatography; Counter current chromatography; High Performance Liquid Chromatography (HPLC); Ultraperformance liquid chromatography (UPLC) and gas chromatography (GC): principle, instrumentation and applications; Oxygen and pH electrodes: principle, instrumentation and applications.

ELECTROPHORESIS & THERMAL METHOD 9 Hours
Electrophoresis: introduction & trouble shooting parameters; Paper, agarose gel, polyacrylamide gel

(PAGE); SDS-PAGE: principle, instrumentation and applications; Immuno, pulse field and capillary electrophoresis; and isoelectric focusing: principle and applications; Thermo gravimetric analysis (TGA): principle, instrumentation and applications.
Case study – PAGE and SDS-PAGE

STRUCTURAL ELUCIDATION AND RADIOISOTOPE METHODS 9 Hours
Mass spectrometry: principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI]) and applications; MALDI-TOF: principle and instrumentation; X-ray diffraction and nuclear magnetic resonance (NMR): principle, instrumentation and applications; Types of radioactive decay; Scintillation counters (ionization and excitation): principle, instrumentation and applications.

Theory: 44 Hours Case study: 1 Hour Total Hours : 45

REFERENCES:

1 Chatwal, G. R., and S.K. Anand. "Instrumental Methods of Chemical Analysis, 5th," 2012. Himalaya Publishing House, India.
2 Sharma, B.K. "Instrumental Methods of Chemical Analysis, 24th." (2014). GOEL Publishing House, India.
3 Wilson, K., and J. Walker. "Principles and Techniques of Practical Biochemistry and Molecular Biology, 7th." (2010). Cambridge University Press, U.K.
4 Skoog, D. A., Holler, F. J., and S. R. Crough. "Instrumental Analysis, 6th." (2007). Brooks Cole Publishing Company. USA.
5 Upadhyay, A., Upadhyay, K., and N. Nath. "Biophysical Chemistry: Principles and Techniques". (2014). Himalaya Publsihing House Pvt. Ltd. India.
6 Segel, Irwin H., and Arwin H. Segel. Biochemical calculations: how to solve mathematical problems in general biochemistry. No. QD415. 3. S43 1975, Wiley, 1992.

OTHER REFERENCES

7 Ahuja, S., and N. Jespersen (Eds). "Comprehensive Analytical Chemistry: Modern Instrumental Analysis" (2006), Vol. 47, Elsevier, Netherlands.
(Google Books)
8 Heftman. E. " Chromatography Vol. 69A. 6th." (2004). Elsevier, Netherlands.
(Google Books)
9 Rajbir Singh. "Chromatography, 1st." (2002). Mittal Publication (Google Books)
10 http://nptel.ac.in/courses.php?disciplineId=102

U15BTT403	FOOD PROCESS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To introduce various pre-processing techniques in food processing
- To understand the methods in processing foods

COURSE OUTCOMES (COS):

At the end of the course student will be able to:

CO 1 : Explain the scope of food processing
CO 2 : Discuss various pre-cleaning techniques in food processing
CO 3 : Describe different types of high temperature processing operations
CO 4 : Explain different drying and dehydration techniques
CO 5 : Discuss low temperature processing and preservation
CO 6 : Describe various post processing operations

PRE-REQUISITE COURSES:

1 U15BTT301 Concepts in Biochemistry

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSPO1**	**PSPO2**
CO1	M					S						S	S	
CO2	M												S	
CO3			M			S				M			S	
CO4				W		S							S	
CO5	S									M			S	
CO 6			M										S	

COURSE ASSESSMENT METHODS:			
Direct		**Indirect**	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

COURSE CONTENT:

INTRODUCTION TO PRE-PROCESSING **12 Hours**

Raw material preparation: cleaning, air screen cleaners, disk, indent cylinder, spiral, and specific gravity, stone, inclined belt, pneumatic , aspirator; separators: magnetic, cyclone, colour separator, grading; sorting; washing; peeling: flash peeling, steam peeling , knife peeling , abrasion peeling ,lye peeling , flame peeling.

PROCESSING USING STEAM OR WATER **9 Hours**

Concepts and equipment used in blanching: Blanching theory, equipment, steam blanchers, hot water blanchers; pasteurization: heat sterilization; extrusion; evaporation, Case study : distillation.

PROCESSING USING HOT AIR AND OIL **9 Hours**

Drying: advantages of drying, moisture content, definition, direct and indirect methods of determination; drying methods: heated air and heated surface drying: hot air dryer, contact dryer, rehydration; drying methods and equipments; osmotic dehydration; baking and roasting: theory and equipment; frying: theory and equipment, Case study: Osmotic dehydration

PRESERVATION BY LOW TEMPERATURE **9 Hours**

Chilling: theory and equipment, freezing equipments, freeze drying equipment, freeze drying, freeze concentration, thawing, Modified atmospheric storage(MAS),controlled atmospheric storage (CAS).

6 Hours

POST PROCESSING OPERATIONS

Coating, enrobing, packaging-, Modified atmospheric packaging(MAP), controlled atmospheric packaging(CAP),filling, sealing.

Theory: 43Hours **Case study:- 2 Hours** **Total Hours Covered:45**

REFERENCES:

1 Fellows, Peter J. *Food processing technology: principles and practice*. Elsevier, 2009.
2 Sahay, K. M., and K. K. Singh. *Unit operations of agricultural processing*. Vikas Publishing House PVT LTD, 2004.
3 Ibarz, Albert, and Gustavo V. Barbosa-Canovas. *Introduction to Food Process Engineering*. CRC Press, 2014.
4 Sahu, Jatindra Kumar, ed. *Introduction to Advanced Food Process Engineering*. CRC Press, 2014.

OTHER REFERENCES:

1 Earle, Richard Laurence. *Unit operations in food processing*. Elsevier, 2013.
2 www.fao.org/wairdocs/x5434e/x5434e00.htm

U15BTT404	CELL AND MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

Objective(s):

- To understand cellular organization, transport of molecules, cell interactions and signaling
- To describe DNA replication, gene expression at transcriptional and translational level gene regulation and DNA repair mechanisms

Course Outcomes :

At the end of the course student will be able to:

CO1 : Recognize the fundamental concepts in the cell structure and function and membrane transport processes.

CO2 : Comprehend the diversified roles of cytoskeletal filaments, the cascade of events in signal transduction

CO3 : Discuss and distinguish the replication of prokaryotic and eukaryotic DNA
CO4 : Describe the synthesis of RNA and post-transcriptional modifications,

CO5 Relate genetic code and protein synthesis
CO6 : Evaluate gene regulation, DNA damage and repair mechanisms

Pre-requisite:
1 U15BTT201:Biomoleculaes and Genetics
2 U15BTT301 Concepts in Biochemistry

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSPO1**	**PSPO2**
CO1	S													
CO2	S									W			W	
CO3	S								M					
CO4	S									M				
CO5	S													
CO6	S						M					W	W	

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Industry survey
3	End semester examination	**3**	Alumni survey

COURSE CONTENT

CELLULAR ORGANIZATION AND MEMBRANE TRANSPORT 9 Hours
Structural organization of prokaryotic and eukaryotic cell: structures and functions; cell cycle; plasma membrane: structure, composition, and functions; membrane transport: passive and active transport; roles of channel proteins: carrier proteins and pumps in membrane transport, bulk transport.

CELLULAR INTERACTIONS AND CELL SIGNALING 9 Hours
Cell adhesion molecules and cell junctions; cytoskeletal proteins and their roles, functions of microtubules, intermediate filaments and microfilaments, Cell signaling models: autocrine, endocrine and paracrine; signal transduction cascade; signaling molecules: receptors, second messengers and protein kinases.
Case Study: relationship between p53 and cancer

NUCLEIC ACIDS AND GENOME REPLICATION **9 Hours**

DNA as genetic material: Griffith, Hershey and Chase, Avery McLeod & McCarty experiments; Extrachromosomal DNA, retroviruses; Molecular organization of chromosomes; Conformations of DNA; DNA replication ; Prokaryotic replication; Replication in eukaryotic chromosomes.
Case study: telomerase and its role

TRANSCRIPTION AND TRANSLATION **9 Hours**

Features of promoters and enhancers; Transcription factors; Classes of RNA molecules; Types of RNA polymerases; Transcription: initiation, elongation, termination; Post-transcriptional modifications: RNA Splicing, Polyadenylation and Capping, RNA editing; RNA Interference (RNAi), ribozymes; Genetic code, Wobble hypothesis, Protein synthesis: Initiation, Elongation, and Termination; Post-translational modifications; Case study: Gene silencing

9 Hours

REGULATION OF GENE ACTIVITY AND DNA REPAIR MECHANISMS

Gene regulation: prokaryotes and eukaryotes, Transcriptional Regulation : *Lac* Operon; Constitutively Expressed Genes: lambda gene regulation lytic and lysogenic cycles, Mutations: point, transition, tranversion, deletion; Mutagens: Physical, Chemical, Biological; DNA Repair Mechanisms; Direct Reversal, Excision Repair
Case study: xeroderma pigmentosum and DNA

Theory: 41 Hours **Case study:- 4 Hours** **Total Hours Covered:45**

REFERENCES:

1 Harvey Lodish, Arnold Berk, S.L Zipursky, Paul Matsudaira, David Baltimore and James Darnell *Molecular Cell Biology*, 4th, W.H Freeman and company, New York,(2002).

2 De Robertis, E.D.P and De Robertis E.M.F. Cell and Molecular Biology, 8th edition, Lippincott Williams and Wilkins, New York,(2001).

3 Rastogi, S.C. "Cell Biology", 2nd Edition, New Delhi: New Age International Publishers. New Delhi, (2004).

4 Friefelder, D., "Molecular Biology", 2nd Edition, Narosa Publishing House, New Delhi. (2009).

5 Lewin B., "Genes IX" Jones and Bartlett, Burlington, (2008).

6 Weaver, R.F. "Molecular Biology", 3rd Edition, McGraw Hill, New York, (2005).

7 Alberts B., Johnson A, Lewis J, Morgan D, Raff M, Roberts K and Walter P., Molecular Biology of The Cell, 6th Edition, Garland Science Publisher, New York, (2014). ISBN:9780815344322

8 Waston, J.D. et al., "Molecular Biology of the Gene", 5th Edition, Pearson Education, (2004).ISBN: 978-0805395921

OTHER REFERENCES:

1 http://www.nature.com/scitable/topic/cell-biology-13906536

2 http://nptel.ac.in/courses/102106025/
3 http://www.dnalc.org/resources/

U15BTT405	BIOTHERMODYNAMICS	L	T	P	C
		3	1	0	4

OBJECTIVE(S)

- To make the students to understand the concepts thermodynamics with examples from bioprocess industries

COURSE OUTCOME(S):

At the end of the course student will be able to:

CO1 : Outline the applications of thermodynamic law and properties of fluids
CO2 : Discuss the principles of partial molar properties and their applications in bioprocess engineering
CO3 : Explain the principles of solution thermodynamics and their applications in bioprocess engineering
CO4 : Explain the principles of phase equilibria problems and their applications in industrial biotechnology
CO5 : Describe the basics principles of chemical reaction equilibria problems and their applications in industrial biotechnology
CO6 : Illustrate the thermodynamic description of microbial growth and product formation

PRE-REQUISITE(S):

1. U15CHT205 Chemistry for Biotechnology
2. U15BTT301 Concepts in Biochemistry
3. U15BTT304 Bioorganic Chemistry

CO/PO MAPPING
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M													S
CO2	S	S	S						M			M		
CO3	S	M	S						M			M		M
CO4		M							M					S
CO5					M		W							
CO6	S	M	M									S		S

COURSE ASSESSMENT METHODS:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey

3	End semester examination	**3**	Industry survey
		4	Alumni survey

THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS **9 Hours**

First Law of thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non ideal behaviour; residual properties; Estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications.

SOLUTION THERMODYNAMICS **9 Hours**

Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation.

PHASE EQUILIBRIA **9 Hours**

Criteria for phase equilibria; VLE calculations for binary and multi component systems **l**iquid-liquid equilibria and solid-solid equilibria

CHEMICAL REACTION EQUILIBRIA **9 Hours**

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.

THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION **9 Hours**

Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert –Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation

.

THEORY: 45 **TOTAL HOURS: 45**

REFERENCE(S):

1. Smith J.M., Van Ness H.C., and Abbot M.M. *Introduction to Chemical Engineering Thermodynamics*, 6th Edition. Tata McGraw-Hill, 2003.
2. Narayanan, K. V. *A Textbook of Chemical Engineering Thermodynamics*. PHI Learning Pvt. Ltd., 2003
3. Christiana D. Smolke, *The Metabolic Pathway Engineering Handbook Fundamentals*, CRC Press Taylor & Francis Group, 2010

OTHER REFERENCE(S):

1. Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley, 1989.
2. http://nptel.ac.in/courses/102106026/

U15BTP401	CELL AND MOLECULAR BIOLOGY LABORATORY	L	T	P	C
		0	0	3	1

Objective(s):

- To familiarize with cell counting and cell separation techniques.
- To acquire practical skills related to DNA/ RNA isolation methods
- To gain hands-on experience with action of restriction endonucleases and ligase on DNA

Course Outcomes :

At the end of the course student will be able to:

CO1 : Demonstrate cell counting and cell separation techniques
CO2 : Carry out DNA isolation from various biological sources.
CO3 : Analyze and interpret DNA data.
CO4 : Evaluate the activity of restriction enzymes and ligase on DNA.
CO5 : Demonstrate bacterial genetics through conjugation experiment
CO6 : Execute the effect of UV irradiation on bacterial genome

Pre-requisite:

1 U15BTP301 Biochemistry and bioorganic chemistry laboratory
2 U15BTP302 Microbiology Laboratory

CO/PO Mapping
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(Pos)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S			M										
CO2	S													
CO3	S			S					M	M				
CO4	S			M										
CO5	S							W						
CO6	S						W					M	W	

Course Assessment methods:

Direct		Indirect	
1	Continuous Assessment	1	Course end survey
2	Internal Tests	2	Industry survey
3	End semester Practical examination	3	Alumni survey
		4	Faculty survey

Course Content

1. Cells separation and cell counting
2. Sonication/ Homogenization of cells followed by differential centrifugation and sub-cellular enzyme localization by enzyme marker
3. Preparation of genomic DNA bacteria/plant/animal sources and analysis DNA using agarose gel electrophoresis
4. Preparation and analysis of plasmid DNA using agarose gel electrophoresis
5. Purification (PCI method) and Quantification (UV spectrophotometer) of DNA
6. Restriction analysis of DNA
7. Ligation of DNA fragments
8. Demonstration of bacterial conjugation
9. Effect of UV light on DNA of bacteria
10. Preparation of Phage lysate and PFU counting
11. Molecular identification of a bacterial strain by 16S rRNA sequencing (Teaching Beyond Syllabus)

Practical: 45 Hours **Total Hours : 45**

REFERENCES:

1 Joseph Sambrook, Peter MacCallum, Molecular Cloning A laboratory Manual, 3rd, CSHL Press, NY, (2000).

2 http://www.dnalc.org

3 Virtual Labs: http://vlab.amrita.edu
Molecular Biology Virtual Lab I
Molecular Biology Virtual Lab II

U15BTP402	UNIT OPERATIONS LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVE(S):

- To apply knowledge on various unit operations in bioprocess industries

COURSE OUTCOME(S):

At the end of the course student will be able to:

CO1 : Illustrate the importance of fluid flow operations in bioprocess industries
CO2 : Demonstrate the applications of particle flow operations in bioprocess industries
CO3 : Exemplify the significance of heat flow operations in bioprocess industries

CO4 : Demonstrate the impact of mass transfer concepts in bioprocess industries.
CO5 : Illustrate the industrial safety equipments in bioprocess industries.
CO6 : Enumerate the chart of various materials (glass/steel/concrete) used in construction.

PRE-REQUISITE(S):
1. U15CHP101 Chemistry Laboratory

CO/PO MAPPING
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M													S
CO2	S	S	S						M			M		M
CO3	S	M	S						M			M		M
CO4		M							M					M
CO5					M		W							S
CO6	S				M				W			W		W

COURSE ASSESSMENT METHODS:

Direct		Indirect	
1	Continuous practical assessment	1	Course end survey
2	End semester practical examination	2	Alumni survey
		3	Industry survey
		4	Faculty survey

COURSE CONTENT **45 Hours**

1 Flow measurement – Venturimeter / Orificemeter / Rotameter
2 Flow through pipes – Straight / Annular
3 Pressure drop studies – Packed / Fluidized beds
4 Size Reduction Equipment – Jaw Crusher
5 Screening Equipments – Rotap / Gyratory
6 Filters – Plate and Frame / Vacuum Leaf
7 Batch Sedimentation test with starch
8 Heat Exchangers – Shell and Tube / Double Pipe
9 Distillation – Simple / Steam / Packed
10 Bioleaching of hexavalent chromium using *Acidithiobacillus thiooxidans* / Reverse Micellar Extraction of Acid dyes / Biosorption of reactive dyes

Teaching Beyond syllabus:
Industrial Visit

Total Hours : 45

Theory: Nil **Practical: 45** **Total Hours : 45 Hours**

REFERENCE(S):

1 McCabe, Warren Lee, Julian Cleveland Smith, and Peter Harriott. *Unit operations of chemical engineering*. Vol. 5. New York: McGraw-Hill, 1993.

OTHER REFERENCE(S):

1 www.che.iitb.ac.in/courses/uglab/manuals/labmanual.pdf
2 www.iitk.ac.in/july14mse/data/MSE314A.pdf

U15BTP403	FOOD TECHNOLOGY AND BIOTECHNIQUES LABORATORY	L	T	P	C
		0	0	3	1

Objectives:

- To provide hands-on training in bioanalytical techniques and related instruments which enable the students to solve the issues
- Operate the HPLC to find the presence and quantification of biochemicals
- To prepare few food products and check their quality

Course Outcomes :

At the end of the course student will be able to:

CO1 : Demonstrate the quality of milk and other food items
CO2 : Display the preparation of bread, wine and other commercially available foods
CO3 : Validate an experiment using absorption spectroscopy
CO4 : Prepare the buffers using pH metry technique applied in many biotechnology industries
CO5 : Operate the spectrophotometer, flame photometer, nephelometer and fluroimeter for the estimation of bioanalytes
CO6 Gain the skill in the area of chromatography

1 U15CHP101 Chemistry Laboratory
2 U15BTP301 Biochemistry and bioorganic chemistry laboratory

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1			M						M				M	
CO2		W	M			M			M				M	
CO3									M				M	
CO4									S				M	
CO5			M											S
CO6		M												S

Course Assessment methods:

Direct		Indirect	
1	Continuous assessment – 2 Internal tests	**1**	Course end survey
2	End semester practical examination	**2**	Faculty survey
		3	Industry survey
		4	Alumni survey

Course Content

EXPERIMENTS: **45 hrs**

1. Preparation of ready-to-serve beverage and estimation of pH, acidity and TSS
2. Preparation of wine and estimation of alcohol content
3. Osmotic dehydration of fruits and vegetables
4. Determination of moisture content in foods
5. Detection of urea in milk
6. Extraction and estimation of preservatives / Isolation of molecules using HPLC
7. Extraction and quantification of bioanalytes. (Calculation of correlation, precision, validity and LOD)
8. Preparation of buffers and determination of pH of an unknown solution (Biological fluids/ plant sources), and Determination of isoelectric point of an amino acid by pH metric titration with a weak acid/ weak base
9. Estimation of aluminum by alizarin red S method using fluorimetry
10. Estimation of sulfate or urinary proteins by nephelometry
11. Identification of biomolecules by thin layer chromatography (TLC) / PTLC

Theory: Nil **Practical: 45 Hrs** **Total Hours : 45**

REFERENCES:

1 David T.Plummer. An Introduction to Practical Biochemistry. 3rd Edition and 33rd reprint. Tata McGraw-Hill Publishing Company Ltd., India, (2008).

2 S.Sadasivam and A.Manickam. Bichemical Methods. 3rd Edition, New Age International Pvt. Ltd., Publishers, India, (reprint, 2010).

3 A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford and P.W.G. Smith, Vogel's Textbook of Practical Organic Chemistry. 5th Edition. Prentice Hall Pvt. Ltd., India, (1996).

4 Segel, Irwin H., and Arwin H. Segel. Biochemical calculations: how to solve mathematical problems in general biochemistry. No. QD415. 3. S43 1975.. Wiley, 1992.

5 Ranganna, Shamanna. Handbook of analysis and quality control for fruit andvegetable products. Tata McGraw-Hill Education, 1986.

6 FSSAI, Manual of methods of analysis of foods. Fruit and vegetable products, 2012.

U15GH*P*401/ PROFESSIONAL VALUES	**L**	**T**	**P**	**C**
(Common to all branches of Engineering and Technology)	**1**	**0**	**0**	**1**

Objectives

1. To sensitize students about being professional
2. To sensitize about the importance of being ethical in one's profession
3. To understand various leadership theories
4. To understand the concept of karma yoga (Self less Work)
5. To be aware of the current strengths and weakness and how to develop on strengths

Course outcomes:

At the end of the course student will be able to:

1. The Students shall acquire knowledge on the Clarity, courage, confidence, commitment, compassion this required for a good professional
2. The Students shall understand the concept of Karma Yoga and lead his/her life accordingly
3. The Students shall understand the importance of ethics in ones profession and practice it
4. The Students shall get acquainted with leadership theories and use them in his/her profession appropriately
5. The Student shall learn how to be an empowered professional and how to empower colleagues

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1		M	W			W	M	M	M			M		
CO2		W				M	S	M	M			S		
CO3					M		S	S	W	W		M		
CO4		W				M	M	M	S	W		M		
CO5		W				M	M	W	M			M		

Course Assessment methods:

Direct	Indirect
1.Individual Assignment 2.Group Assignment 3.Presentation 4.Surprise Test 5.Practical Assessment 6.End Semester Assessment	1.Attendance and Behavioural Assessment

Introduction to Professional Values	1 Period
Concept of Integral Karma Yoga	3 Periods
Professional Ethics	3 Periods
Eastern and Western Leadership Theories	2 Periods
Empowerment of a Professional	4 Periods
Advanced Contemplative Practices with Demonstrations	2 Periods
	Total Periods: 15

References Books:

1. Rishabhchand, *"Integral Yoga of Sri Aurobindo*", Sri Aurobindo Ashram Publication Department, Pondicherry, Published 2001.
2. Charles E Harris, "*Engineering Ethics: Concepts and Cases*", 4th edition, Western Michigan University, Published 2009.
3. Devdas Menon, "*Spirituality at Work*", professor of structural engineering at IIT Madras.
4. Ameeta Mehra, "*Karma Yoga: Perfection in Work*", The Gnostic Centre, New Delhi, Published 2000.
5. Winthrop Sargeant,"*The Bhagavad Gita"*, State University of New York, Published 1994.
6. D.R Kiran, *"Professional Ethics& Human Values"*, The Mc Graw Hill/BSP Books, Published 2013.
7. S. Bhaskar, *"Professional Ethics& Human Values"*, The Aunradha Agencies, Chennai, Published 2005.
8. Keith Ward & Cliff Bowman, *"Extraordinary performance from ordinary people",* Routledge, Published 2007.
9. Stephen Robbins, "Organization Behavior", The Prentice Hall; 15 editions, 2012.

SEMESTER V

U15BTT501	GENETIC ENGINEERING AND GENOMICS	L	T	P	C
		3	0	0	3

Objectives:

- To learn various types of host-vector systems and steps in creating a recombinant DNA molecule
- To gain knowledge on various recombinant DNA techniques and their applications.
- To understand the genomics techniques

Course Outcomes :

At the end of the course student will be able to:

CO1 : Comprehend the steps in recombinant DNA construction
CO2 : Analyse the features of various types of gene cloning vectors
CO3 : Apply recombinant technology in solving real world problems
CO4 : Analyse biosafety and Bioethics in using GMOs
CO5 : Describe genome organization and genome sequencing methods
CO6 : Explain the genome wide gene expression

Pre-requisite:

1 U15BTP404 Cell and Molecular Biology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S													
CO2	S	M	W		M					S				
CO3		M			M								S	M
CO4						S		S				M	S	
CO5					M				S					
CO6	S												W	

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course Content

BASICS OF RECOMBINANT DNA TECHNOLOGY 9 Hours

Restriction and modifying enzymes, construction of recombinant DNA molecules, transformation of r-DNA molecules into target host organisms: Calcium chloride mediated, electroporation, microinjection, gene gun, selection methods for recombinants: antibiotic resistance, blue and white selection, GFP and Luciferase based selection.

Case study: mode of action of a selection marker

CLONING AND EXPRESSION VECTORS 9 Hours

Cloning vector; properties of a cloning vector: origin of replication, polylinker region, selectable marker gene; Plasmid Vectors: Lambda phage vectors, phagemid, cosmid, shuttle vector, expression vectors; yeast vectors , Baculoviral based vector, mammalian expression vectors, plant transformation vector; binary vector, high capacity vector;YAC

Case study: Latest multipurpose expression vector

GENE CLONING AND APPLICATIONS 12 Hours

Construction and screening of genomic and cDNA libraries, over-expression and purification of recombinant His tag fusion proteins using Ni+ column. Blotting techniques: Southern, northern,western blotting, Polymerase Chain Reaction (PCR); DNA fingerprinting using molecular markers: RAPD, RFLP, gene silencing: RNAi and gene knock-out; site directed mutagenesis, Application of genetically modified organisms: medicine, agriculture, Biosafety levels for microbes, plant and animals, safety guidelines and release procedure for GMOs in India,

Case study: Use of PCR and RFLP in forensic field.

GENOME MAPPING AND SEQUENCING 9 Hours

History and mile stones of human genome project, Genome organization: prokaryote, eukaryote; complexity of genomes; genome mapping: FISH, optical mapping, STS content mapping, Advanced DNA sequencing methods: pyrosequencing, nanopore sequencing, genome sequencing methods: top-down approach, bottom- up approach; genome sequence assembly; comparative study on the genome sequencing methods

Case study: Optical mapping

FUNCTIONAL GENOMICS 6 Hours

Differential gene expression analysis; DDRT- PCR, subtractive hybridization, representational display analysis, Serial Analysis of Gene Expression, Microarray: fabrication of cDNA based array, DNA chip; application microarray in gene expression analysis.

Case study: Analysis and interpretation of microarray data

REFERENCES:

1 Glick B.R.,and Pasternick J.J., Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rd Edition, ASM press, Eashington, (2003).

2 Brown T.A., Genomes 2, Bios Scientific Publishers Ltd, Oxford, 3rd edition, (2006).

3 Primrose S.B., TwymanRM., Principles of Gene Manipulation and Genomics , 7th Edition, Blackwell Science,(2006).

OTHER REFERENCES:

5 http://nptel.ac.in/courses/102103013/

6 http://www.lsic.ucla.edu/ls3/tutorials/gene_cloning.html

U15BTT502	ENZYME TECHNOLOGY	L	T	P	C
		3	0	0	3

Objectives:

- To understand the basics of enzymes and classification and enzyme kinetics
- To study the extraction, purification and characterization of enzymes
- To study the enzyme applications and biosensors

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 Describe the basics of enzymes, nomenclature and classification

CO2 Apply the knowledge to derive the kinetics for enzymes

CO3 Illustrate and apply the different techniques for immobilization of enzymes and kinetics

CO4 Apply the knowledge on design of enzyme reactors

CO5 Discuss the applications of enzymes in different industries

CO6 Summarize the applications of enzyme based Biosensor

Pre-requisite:

1 U15BTT301 Concepts in Biochemistry

2 U15BTT303 Concepts of Industrial Biotechnology

CO/PO Mapping

S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S		M	M										
CO2	S		S											
CO3	S				S									

CO4	S	S		M										
CO5	S		M											
CO6	S				M									

Course Assessment methods:

	Direct		Indirect
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

INTRODUCTION TO ENZYMES **9 Hours**

Introduction of enzymes: Nomenclature and Classification of enzymes; concept of active site, substrate binding site, allosteric site, and energetics of enzyme substrate complex formation; specificity of enzyme; Mechanisms of enzyme action; Enzymes in organic solvents; Introduction to enzyme activity and specific activity calculations.

ENZYME KINETICS **9 Hours**

Kinetics of single substrate reactions: Michelis & Menten equation, Estimation of Michaelis & Menten parameters: Lineweaver-Burk plot, Eadie-Hofstee plot and Hanes plot; Bisubstrate reactions: single displacement and ping pong mechanism; Multi substrate reactions: King and Altmann equation; Types of inhibition: Competitive, Uncompetitive, noncompetitive inhibition; Allosteric regulation of enzymes; Monod Changeux Wyman model.

ENZYME IMMOBILIZATION **9 Hours**

Physical and chemical techniques for enzyme immobilization: adsorption, matrix entrapment, encapsulation, cross-linking and covalent binding and their advantages and disadvantages; Applications of immobilized enzymes.

PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES **9 Hours**

Extraction and purification of enzyme from plant, animal and microbial sources; Methods of characterization of enzymes; Development of enzymatic assays; Case study on extraction of Papain, Chymosin and cellulase enzymes

ENZYME APPLICATIONS **9 Hours**

Application of enzymes in industries: Food, detergent, leather, wool, brewery, and environment; Design of enzyme electrodes and their applications as biosensors in industry, health care and environment.
Case study - Development of enzyme based biosensors for environmental applications.

Theory: 43h Tutorial /Case study: 2h Total Hours Covered:45

REFERENCES:

1 Trevor Palmer, Enzymes (2007); Biochemistry, Biotechnology and Clinical Chemistry, 2nd Edition, Horwood Publishing Limited, United Kingdom.

2 Ashok Pandey, Collin Web, Carlos Ricard and Christian Larroche, (2006); Enzyme Technology, 2nd Edition, Springer Science + Business Media Inc. and Asiatech Publishers, Netherlands.

3 Nicholas Price and Lewis Stevens, (2009); Fundamentals of Enzymology, 3rd Edition, Oxford University Press, India.

OTHER REFERENCES:

1 Shanmugham.S and Sathishkumar.T, (2012); Enzyme Technology, Second edition, India, 2012.

2 http://www.novozymes.com/en/about-us/our-business/what-are-enzymes/Pages/default.aspx

U15BTT503	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Objectives:

- To learn different types of bioreactors and their components
- To understand microbial growth kinetics in batch, fed-batch and continuous mode
- To study the basics of scale-up criteria for bioreactors

Course Outcomes :

At the end of the course student will be able to:

CO1 : Understand the different bioreactors and their applications
CO2 : Discuss and distinguish the medium requirements and optimization methods
CO3 : Explain the sterilization kinetics of medium and equipments
CO4 : Describe batch, fed-batch and continuous cultivation and their kinetics.
CO5 : Understand the scale-up criteria for bioreactors.
CO6 : Discuss the products produced through fermentation process

Pre-requisite:

1 U15BTT302Microbiology
2 U15BTT401 Concepts of Industrial Biotechnology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(Pos)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M								S					M
CO2	S	S		M	S					M		M		M
CO3	S	M	S							S				S
CO4				S	S				M					S
CO5	S	M		M										M
CO6		S			M							M		M

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

RAW MATERIALS ANDMEDIA OPTIMIZATION METHODS 9 Hours
Criteria for good medium; Various carbon, nitrogen, minerals, vitamins and other complex nutrients for fermentation industry; Simple and complex media for microbial, plant and animal cells; oxygen requirements; medium formulation for optimal growth and product formation; medium optimization methods: Plackett-Burman design, simplex design and response-surface methodology.
Case study: Enzyme production using Plackett-Burman design

STERILIZATION KINETICS 9 Hours
Thermal death kinetics of microorganisms; batch and continuous heat sterilization of liquid media; filter sterilization of liquid media; sterilization of air; design of sterilization equipment for batch and continuous process.

KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 9 Hours
Modes of operation – batch, fed-batch and continuous cultivation, Simple unstructured kinetic models for microbial growth : Monod model; Growth of filamentous organisms and yeast. Product formation kinetics; Leudeking-Piret models, substrate and product inhibition on cell growth and product formation.
Case study: Production of penicillin by fed-batch cultivation

TYPES AND APPLICATIONS OF BIOREACTORS 9 Hours

Aeration and agitation in bioreactors; Rheology of fermentation fluids; Main parameters to be monitored and controlled in fermentation processes. Types and industrial applications of bioreactors; stirred-tank reactor and its ancillaries; bubble-column reactor; packed-bed reactor; fluidized-bed; air-lift reactor; and photobioreactor;

SCALE-UP OF BIOREACTORS **9 Hours**

Scale-up criteria for bioreactors; Major factors involved in scale-up; Scaling-up of mixing systems; Scale-up of aeration/agitation regimes in stirred tank reactors. Scale-up of air-lift reactors.

Case study: Scale-up of a reactor for wastewater treatment using mixed culture / metabolite production

Theory: 42 Hours **Case study: 3 Hours** **Total Hours : 45**

REFERENCES:

1 Shuler, M. L., and F. Kargi. "Bioprocess Engineering: Basic Concepts, 2nd."(2002). New Delhi, Prentice-Hall of India.

2 Stanbury P. F., Hall, S., and Whitaker A, "Principles of Fermentation Technology", 2nd Edition, Butterworth-Heinesmann, 2003.

3 Blanch H. W. And Clark D. S, "Biochemical Engineering, 2nd." (2007). CRC Press, London.

4 Pauline M. Doran, "Bioprocess Engineering Principles, 2nd." (2012) Academic Press, New York.

5 Bailey and Ollis, "*Biochemical Engineering Fundamentals, 2nd."(2010). McGraw-Hill, New Delhi.*

6 Lee, J. M. (1992). *Biochemical engineering*. Englewood Cliffs, NJ: Prentice Hall.

OTHER REFERENCES:

1 Rajiv Dutta, "Fundamentals of Biochemical Engineering", Ane Books India, New Delhi, 2008

2 http://www.nptel.ac.in/syllabus/syllabus.php?subjectId=102107029

3 http://users.ox.ac.uk/~dplb0149/publication/NPRBiocatalysisRev.pdf

4 http://link.springer.com/book/10.1007%2F978-1-4684-0324-4

U15BTT504	HEAT AND MASS TRANSFER IN BIOPROCESS	L	T	P	C
		3	1	0	4

OBJECTIVE(S)

- Make the students to describe the applications of heat transfer operations with relevance to bioprocess engineering
- Make the students to explain the concepts of mass transfer in bioprocess engineering

COURSE OUTCOME(S):

At the end of the course student will be able to:

CO1 : Outline the modes of heat of transfer
CO2 : Explain the applications of heat transfer in bioprocess industries
CO3 : Illustrate the principles of diffusion and apply the concepts of interphase mass transfer in bioreactor
CO4 : Describe the concept of distillation and adsorption in bioprocess industries
CO5 : Explain the extraction and its application in bioprocess industries
CO6 : Explain the leaching and its application in bioprocess industries

PRE-REQUISITE(S):
1. U15BTT304 Stoichiometry and fluid mechanics in bioprocess
2. U15BTT405 Biothermodynamics

CO/PO MAPPING
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M													S
CO2	S	S	S						M			M		W
CO3	S	M	S						M			M		
CO4		M							M					M
CO5					M		W							M
CO6					M		W							M

COURSE ASSESSMENT METHODS:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

COURSE CONTENT:

HEAT TRANSFER **12 Hours**

Modes of heat transfer; Conduction: Fourier's law, Thermal conductivity of biological materials, Conduction through plane wall, hollow cylinder and hollow sphere, Insulating materials; Convection: Individual and overall heat transfer coefficients, Dimensional analysis for free and forced convection, Heat transfer to fluids with and without phase change, Conduction and convection in bioprocess industries.

HEAT TRANSFER EQUIPMENTS **12 Hours**

Heat Exchangers: Basic calculations, Heat transfer configurations for bioreactors, Heat exchangers for sterilization, Compact and extended surface heat exchangers; Mechanism of condensation and boiling; Evaporators: Industrial evaporators, Methods of operation, Overall

heat transfer coefficient, Single effect evaporator calculations, Evaporation of biological materials, Heat exchangers and evaporators in bioprocess industries.

DIFFUSION AND INTERPHASE MASS TRANSFER 12 Hours

Modes of mass transfer; Diffusion: Fick's first law, Molecular diffusion in gases, liquids and solids; Interphase mass transfer: Individual and overall mass transfer coefficients for liquids and gases, Theories of mass transfer; Mass transfer in bioreactors: Methods for the determination of k_La, Factors affecting oxygen transfer rate.

DISTILLATION AND ADSORPTION 12 Hours

Distillation: Overview of vapour-liquid equilibria, Flash, differential, continuous, steam, azeotropic and extractive distillation, Determination of number of stages by McCabe-Thiele method; Adsorption: Types of adsorption, Nature of adsorbents, Adsorption isotherms-Langmuir and Freundlich, Adsorption kinetics and thermodynamics, Batch and continuous adsorption, Applications of distillation and adsorption in bioprocess engineering.

EXTRACTION AND LEACHING 12 Hours

Extraction: Ternary liquid-liquid equilibria, choice of solvents, Single and multistage extraction, Co-current and cross-current extraction; Leaching: Single stage leaching, Extraction and leaching equipments, Applications of extraction and leaching in bioprocess engineering.

THEORY: 45 TUTORIAL: 15 TOTAL HOURS: 60

REFERENCE(S):

1. Kern, Donald Quentin. *Process heat transfer*. Tata McGraw-Hill Education, 1950.
2. Treybal, Robert Ewald, and E. Treybal Robert. *Mass-transfer operations*. Vol. 3. New York: McGraw-Hill, 1968.
3. McCabe, Warren Lee, Julian Cleveland Smith, and Peter Harriott. *Unit operations of chemical engineering*. Vol. 5. New York: McGraw-Hill, 1993.
4. Shuler, Michael L., and Fikret Kargi. *Bioprocess engineering*. New York: Prentice Hall, 2002.
5. Doran, Pauline M. *Bioprocess engineering principles*. Academic press, 1995.

OTHER REFERENCE(S):

1. http://nptel.ac.in/courses/103103032
2. http://nptel.ac.in/courses/103103035/

U15BTT505	IMMUNOLOGY AND MICROBIAL PATHOGENESIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the general concepts of immune system, immune organs and cells
- To know about the mechanisms related to cell mediated immunity, complement system, hypersensitivity and transplantation immunology.
- Students understand principles of microbial pathogenesis, clinical importance of specific pathogens and diagnostic methods.

COURSE OUTCOMES :

At the end of the course student will be able to:

CO1 : Outline the general concepts of immune system and describe the cells and organs of the immune system ; Students understand principles of microbial pathogenesis, clinical importance of specific pathogens

CO2 : Describe the properties of antigens and antibodies; Students can learn importance of Host defense mechanisms and pathogen adaptation against host defense.

CO3 : Demonstrate various antigen-antibody interactions and techniques; Students understand molecular mechanisms involved in Pathogenesis of diseases caused by various pathogenic organisms

CO4 : Illustrate the mechanisms behind hypersensitivity and transplantation immunology; the mechanisms behind hypersensitivity and transplantation immunology

CO5 : Explain the concept of cell mediated immunity and complement system; Students understand host-pathogen interaction with respect to pathological damage of pathogens

CO6 : Students understand host-pathogen interaction with respect to pathological damage of pathogens and explore the diagnostic methods

PRE-REQUISITE:

1 U15BTT302 Microbiology

2 U15BTT404 Cell and molecular biology

CO/PO Mapping
(S-Strong, M-Medium, W-Weak)

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S		M									S	W	
CO2	S			W									W	
CO3	S	M			S									
CO4	S												S	
CO5			S										S	
CO6				M									S	

COURSE ASSESSMENT METHODS:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

COURSE CONTENT

IMMUNE SYSTEM AND MICROBIAL PATHOGENESIS 7 Hours

Historical background, general concepts of the immune system and three lines of defence; Infectious diseases: Molecular Koch postulates; Clinical importance of pathogenic bacteria, fungi, virus and parasite with examples; Principles of microbial pathogenesis: Microbial modes of entry mechanism and colonization; Components of microbial pathogenesis

CELLS AND ORGANS OF IMMUNE SYSTEM 12 Hours

Innate and adaptive immunity. Structure, properties and functions of the immune cells: Hematopoeisis, T and B-lymphocytes, NK cells; Monocytes and macrophages; Neutrophils, eosinophils, and basophils Mast cells and dendritic cells; Inflammation process; Antigens and haptens; B and T cell epitopes. T-dependent and T- independent antigens. Antibodies: Classification, Structure, function and properties of the antibodies; Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype); MHC, complement pathways; Antimicrobial compounds; Mechanism of killing by humoral and cellular defense mechanisms; Pathogenic adaptations to overcome the above defenses.

IMMUNE SYSTEM IN HEALTH AND DISEASE 7 Hours

Immunity to: Viruses, Bacteria, Fungi and Parasites; Vaccines: Immunodeficiency and AIDS; Cancer and the Immune System; Hypersensitive reactions; Tolerance and Autoimmunity; Transplantation Immunology introduction: Types of grafts, immunologic basis of graft rejection.

MOLECULAR MICROBIAL PATHOGENESIS (SPECIFIC EXAMPLES) 9 Hours

Clinical features and molecular mechanism of pathogenesis: Enteric pathogens *E.coli* pathogens; *Shigella*; *Salmonella*; *Vibrio* - PAI; Superficial mycoses: Dermatophytes, Candidiasis; Malaria Parasite: Plasmodium and life cycle; Influenza virus: Intracellular stage, H1N1; HIV.

ANTIGEN-ANTIBODY INTERACTIONS AND DIAGNOSTICS 10 Hours

Immunological principles of various reactions and techniques: Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA -types, Western Blotting, southern blotting; Hybridoma technology-Monoclonal antibodies production and applications. Virulence, virulence factors Virulence assay: Adherence, cytopathic, cytotoxic; Criteria and tests in identifying virulence factors- Classical, biochemical, genetic and genome approaches; Molecular characterization of virulence factors.

Theory: 45 Hours **Total Hours : 45**

REFERENCES:

1 Kuby, J. H. (2007). Immunology, 6th Edn., W. H. Freeman Publication, New York, USA

2 Abbas, K. A., Litchman, A. H. and Pober, J. S. (2007). Cellular and Molecular Immunology, 4thEdn., W. B. Saunders Co., Pennsylvania, USA

3 Roitt, I., Brostoff, J. and David, M. (2008). Immunology, 11th Edn., Mosby publishers Ltd., New York, USA

4 Tizard, R.I. (2007). Immunology: An Introduction 1st Edition (English) 4th Edition, Brooks/Cole publishers.

5 Chakaravarthy, A.K. (2006) Immunology and Immunotechnology 1st Edition (English) 1st Edition, Oxford University Press India.

6 David Greenwood, Richard C. B. Slack and John. F. Peutherer (2007) "*Medical Microbiology- A guide to microbial infections: Pathogenesis, Immunity, Lab Diagnosis and Control".*Edn. 16. Churchill Livingstone- An imprint of Elsevier.

7 Peter Williams, Julian Ketley& George Salmond, (1998) "*Methods in Microbiology: Bacterial Pathogenesis",* Vol. 27, Academic Press

8 Camille Locht and Michel Simonet (2012) "Bacterial *Pathogenesis- molecular and Cellular Mechanisms".* Caister Academic Press.

9 Eduardo A. Groisman (2001) "*Principles of Bacterial Pathogenesis"*, Academic Press, USA/UK.

10 Kathleen Park Talaro and Arthur Talaro, (2002) "*Microbiology"*, 4th edition, McGraw Hill.

OTHER REFERENCES:

1 http://www.raymondcheong.com/Year1/immuno.html

2 http://ocw.mit.edu/courses/health-sciences-and-technology/hst-176-cellular-and-molecular-immunology-fall-2005/lecture-notes/

3 http://www.umich.edu/~bmsteach/lopatin/Immunology/Immunology.html

4 http://www.textbookofbacteriology.net/

5 https://www.boundless.com/microbiology/

6 http://www.microbiologybook.org/

7 http://nptel.ac.in/courses/102103038/#

U15ENP501- COMMUNICATION SKILLS LABORATORY

(Common to all branches of Engineering and Technology)

L	T	P	C
0	0	3	1

OBJECTIVES

- To impart communicative ability to exhibit the individual's subject knowledge
- To achieve the desirable communicative competence by the students to meet the expectation of corporate
- To show the need for a comprehensive link language to share subject expertise
- To offer adequate exposure to soft skills needed for the corporate.
- To sensitize towards corporate culture.

COURSE OUTCOMES

At the end of the course student will be able to:

CO1: Imparting the role of communicative ability as one of the soft skills needed for placement
CO2: Developing communicative ability and soft skills needed for placement
CO3: Making students Industry-Ready through inculcating team-playing capacity
CO4: Effectively communicate electronically
CO5: Deliver clear lectures to the public and scientific gathering
CO6: Effective use of body language and interview question handling

Prerequisite course:U15ENT101 Technical English

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1			S		M					S				
CO2	S	S			S		M			S				
CO3	S	S		S	S				S		M	S		
CO4														
CO5	S													
CO6					S					S				

Course Assessment methods:

Direct		Indirect	
1	Model examination	1	Course end survey
2	End semester examination	2	Faculty survey
		3	Industry
		4	Alumni

GRAMMAR IN COMMUNICATION **9 hours**

Grammar and Usage – Building Blocks, Homonyms, Subject and Verb Agreement, Error Correction - Grammar Application, Framing Questions – Question words, Verbal Questions, Tags, Giving Replies –Types of Sentences, Listening Comprehension –Listening and Ear training.

ASSERTIVE COMMUNICATION **9 hours**

Listening Comprehension in Cross–Cultural Ambience, Telephonic Conversations/Etiquette, Role Play Activities, Dramatizing Situations- Extempore – Idioms and Phrases.

CORPORATE COMMUNICATION **9 hours**

Video Sensitizing, Communicative Courtesy – Interactions – Situational Conversations, Time Management, Stress Management Techniques, Verbal Reasoning, Current Affairs – E Mail Communication / Etiquette.

PUBLIC SPEAKING **9 hours**

Giving Seminars and Presentations, Nuances of Addressing a Gathering - one to one/ one to a few/ one to many, Communication Process, Visual Aids & their Preparation, Accent Neutralization, Analyzing the Audience, Nonverbal Communication.

INTERVIEW & GD TECHNIQUES **9 hours**

Importance of Body Language –Gestures & Postures and Proxemics, Extempore, Facing the Interview Panel, Interview FAQs, Psychometric Tests and Stress Interviews, Introduction to GD, Mock GD Practices.

Theory: NIL **Practical: 45 Hours** **Total Hours : 45**

REFERENCES:

1. Bhatnagar R.P. & Rahul Bhargava, "English for Competitive Examinations", Macmillian Publishers, India, 1989, ISBN: 9780333925591
2. Devadoss K. & Malathy P., "Career Skills for Engineers", National Book Publishers, Chennai, 2013.
3. Aggarwal R.S., "A Modern Approach to Verbal & Non–Verbal Reasoning", S.Chand Publishers, India, 2012, ISBN : 8121905516

U15BTP502	ENZYME TECHNOLOGY LABORATORY	L	T	P	C
		0	0	3	1

Objectives:

- Provide hands-on training on the assay of different enzymes and kinetics
- To familiarize the students with solid state fermentation and its applications
- To expose the students to the proper handling of fermenters

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 : Perform isolation of enzymes from natural sources
CO2 : Demonstrate the production of enzymes
CO3 : Perform partial purification of enzymes
CO4 : Execute the enzyme activity and immobilized enzyme
CO5 Perform the applications of enzymes
CO6 Demonstrate the bioreactor and modes of operation

Pre-requisite:

1 U15BTP301 Biochemistry lab

2 U15BTP302 Microbiology Lab

CO/PO Mapping

(S/M/W indicates strength of correlation)

S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M			M	S								W	M
CO2	S			S			M						M	M
CO3	S	M		S			M		M				M	W
CO4	M				M		S						S	W
CO5	S			M									S	S
CO6		S			M								W	M

Course Assessment methods:

Direct

1 Model Examination

2 End semester examination

Indirect

1 Course end survey

2 Faculty survey

3 Industry survey

4 Alumni survey

Course Content **Hours**

1. Isolation of industrially important enzymes (α-Galactosidase / Papain / Amylase / xylanase / cellulase) from natural source
2. Production of enzymes (α-Galactosidase / Papain / Amylase / xylanase / cellulase) by SmF / SSF using industrial / agriculture residues
3. Enzyme assay - α-Galactosidase / Papain / Amylase / xylanase / cellulase
3. Partial purification of enzymes by salt/solvent/ Ultra-filtration
4. Effect of pH and Temperature on enzyme activity
5. Enzyme kinetics – Estimation of Michaelis-Menten parameters
6. Enzyme inhibition kinetics
7. Enzyme immobilization – Gel entrapment / cross-linking
8. Production of amylase/cellulase/protease using immobilized microbes
9. Application of protease in detergent industry
10. Hydrolysis of raffinose and stachyose by immobilized α-galactosidase
11. Introduction to enzyme reactors (Case study)

Theory: NIL **Practical: 45 Hours** **Total Hours : 45**

U15BTP503	GENETIC ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1

Objective(s):

- To gain hands on experience in amplifying a gene
- To acquire skill in preparing recombinant DNA molecule
- To perform DNA fingerprinting using RAPD

Course Outcomes :

At the end of the course student will be able to:

CO1 : Design primers for PCR and analyse PCR product
CO2 : Construct and analyse a recombinant DNA clone
CO3 : Analyse recombinant proteins using PAGE
CO4 : Apply PCR methodology for disease diagnosis
CO5 : Execute DNA fingerprinting technique to construct phylogenetic tree
CO6 : Analyse plant transformation (binary vector) of *Agrobacterium tumefaciens*

Pre-requisite:

1 U15BTP401 Cell and Molecular Biology Lab

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1		S			W					S				
CO2		S				W		W	S					
CO3				M										
CO4												S		
CO5					S								M	
CO6	S												M	

Course Assessment methods:

	Direct		Indirect
1	Continuous assessment	1	Course end survey
2	Internal tests	2	Industry survey
3	End semester practical examination	3	Alumni survey Faculty survey

Course Content **Hours**

1. PCR amplification of DNA fragment using gene specific primers
2. Elution of DNA from agarose gel using silica column and calculation of Insert-vector ratio and Ligation of a PCR product in plasmid vector
3. Preparation and Transformation of competent cells (BL21 (DE3) *E.coli* by heat-shock method
4. Selection of recombinant clones using blue & white selection
5. Confirmation of presence of insert in the recombinant clones by colony PCR
6. Optimization of inducer concentration for recombinant protein expression
7. Confirmation of recombinant protein using Western blotting
8. DNA fingerprinting by RAPD analysis
9. Analysis of binary plant transformation vector in *Agrobacterium tumefaciens*
10. Molecular diagnosis of bacterial infection in a sample

Total Hours : 45

Theory: NIL **Practical: 45 Hours** **Total Hours : 45**

REFERENCES:

1 Joseph Sambrook, Peter MacCallum, Molecular Cloning A laboratory Manual, 3rd Edition, CSHL Press, NY, (2000).

ONLINE REFERENCES:

1 http://www.dnalc.org

U15BTP504	IMMUNOLOGY AND MICROBIAL PATHOGENESIS LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To develop skills of students in Immunological techniques by performing simple experiments in the laboratory
- To perform techniques like blood grouping, ELISA, & identification of T-cell
- To study the applications of immuno-techniques for identification of microbial pathogenesis

COURSE OUTCOMES :

At the end of the course student will be able to:

CO1 **:** Learn to handle serum, prepare antigens and Identify blood cells and its components

CO2 **:** Obtain knowledge for identification of immunological cells in our circulatory system

CO3 **:** Understand and apply Immunological techniques to know about Ag – Ab interaction during microbial pathogenesis

CO4 **:** Acquire knowledge through agglutination reactions occur when antibodies react with particulate antigens on a cell surface.

CO5 **:** Perform Immuno assay to understand complement fixation system

CO6 **:** Understand the antigen and antibody interactions through immunoelectrophorosis

PRE-REQUISITE:

1 U15BTP302 Microbiology Laboratory

2 U15BTP401 Cell and Molecular Biology Laboratory

CO/PO Mapping
(S-Strong, M-Medium, W-Weak)

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1			M					S						
CO2				W										
CO3		M			S									
CO4														
CO5			S											
CO6				S										

Course Assessment methods:

Direct		Indirect	
1	Internal Test Practical	**1**	Course end survey
2	End semester practical examination	**2**	Faculty survey
		3	Industry survey
		4	Alumni survey

Course Content

HAEMATOLOGY AND IMMUNE CELLS

1 Blood smear preparation and identification of leucocytes by Giemsa stain
2 Serum separation, and storage
3 Separation of Mononuclear cells by Ficoll-hypaque
4 Separation of leucocytes by dextran method

IMMUNOLOGY – AGGLUTINATION

5 Identification of ABO blood group with Rh-factor
6 Haemagglutination and Latex Agglitination Test
7 Widal and VDRL Test

8 Complement Fixation
IMMUNOLOGY – PRECIPITATION
9 Ouchterlony Double Immuno Diffusion
10 Immunoelectrophoresis
11 Single Radial Immunodiffusion
12 Rocket Immunoelectrophoresis
13 Enzyme Linked Immuno Sorbent Assay (ELISA)

Theory: Nil **Practical: 45** **Total Hours : 45**

REFERENCES:

1 Hudson L. and Hay H. C (2008) Practical Immunology-. Blackwell Scientific Publications.
2 Frank C. Hay, Olwyn M. R. Westwood, Paul N. Nelson and Leslie Hudson W (2006) Practical Immunology, Wiley-Blackwell Publications.
3 Rollins, D.M., J.J. Temenak, P. Shields and S.W. Joseph. Microbial Pathogenesis Laboratory Manual. 2nd Edition, Published & Available Online. 2003.

OTHER REFERENCES:

1 https://sites.google.com/site/hoaisclassroom/classroom-news/labmanual-immunology
2 http://www.nvcc.edu/manassas/biotech/Immunology_Manual.pdf
3 http://www.life.umd.edu/classroom/bsci424/

U15GH*P*501/ SOCIAL VALUES	**L**	**T**	**P**	**C**
(Common to all branches of Engineering and Technology)	**1**	**0**	**0**	**1**

Objectives

1. To understand the genesis of society and social values
2. To understand the various sources of disparity among human beings
3. To empathize social issues and offer solutions wherever possible
4. To learn about social welfare organizations

Course outcomes:

At the end of the course student will be able to:

1. The students shall acquire knowledge about how societies are formed and social values are created
2. The students shall understand and empathize various social issues and contribute towards finding a solution
3. To understand the causes of disparity among human beings
4. To know about social welfare organizations and to use social media effectively
5. To understand various social parameters that influences individual and society at large

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		W				M	W	M	W			M		
CO2		W	W			W	M	M		W		M		
CO3		W				M	W	S				M		
CO4		W				S		M	W	M		S		
CO5			W		W	M	W			W		M		

Course Assessment methods:

Direct	Indirect
1.Individual Assignment 2.Group Assignment 3.Presentation 4.Surprise Test 5.Practical Assessment 6.End Semester Assessment	1.Attendance and Behavioural Assessment

Introduction to Social Values – Society	2 Periods
Development of Science, Education, Politics & Economics	3 Periods
Disparity among human beings	3 Periods
Social Issues & Welfare	3 Periods
Social Welfare Organizations	2 Periods
Yogasanas & Meditation	2 Periods

Total Periods: 15

References Books:

1. Swami Vivekananda, "*Prosperous India"* 1st edition, The Ramakirshna Mission Institute of Culture, 1937.
2. Fritz Schumacher, *"Small is Beautiful",* The Blond & Briggs, Published 1973.
3. Vethathiri Maharishi*, "Logical Solutions for the Problems of Humanity",* The World Community Service Centre, Vethathiri Publications, 1999.
4. Sarvepalli Radhakrishnan, *"The Source Book on Indian Philosophy"*, Princeton, N.J. : Princeton University Press, 1957.
5. Sarvepalli Radhakrishnan, *"Religion, Science and Culture",* The Orient Paperbacks, India, Published 1994.
6. Vethathiri's Maharishi's, *"Vethathirian Principles of Life"* The World Community Service Centre, Vethathiri Publications, 2003.

SEMESTER VI

U15BTT601	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	1	0	4

OBJECTIVE(S)

- To make the students to apply the concepts of reaction mechanism and kinetics for biochemical and microbial reactions
- To make the students to design a reactor for biological reactions

COURSE OUTCOME(S):

At the end of the course student will be able to:

CO1: Revise the basic laws on chemical kinetics and their applications in reactions.
CO2: Compare the various ideal reactors and their design equations
CO3: Describe the non ideal behaviour of reactors and their models
CO4: Explain the kinetics for heterogeneous reacting systems
CO5: Outline the G/L reactions on solid catalysts.
CO6: Compare the various multiphase reactors and their applications in bioprocess industries

PRE-REQUISITE(S):

1. U15CHT101 Engineering Chemistry
2. U15BTT405 Biothermodynamics
3. U15BTT502 Enzyme Technology
4. U15BTT503 Bioprocess Engineering

CO/PO MAPPING
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M													M
CO2	S	S	S						M	M		M		M
CO3	S	M	S						M	M		M		S
CO4		M							M	M				M
CO5					M		W							M
CO6					M		W							M

COURSE ASSESSMENT METHODS:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

COURSE CONTENT:

REACTION KINETICS **12 Hours**

Reactions: Classifications, order and molecularity, rate equation, rate constant; Concentration and temperature dependence, Activation energy; Search for reaction mechanism; Methods of analyzing batch reactor data: Integral and differential; Analysis of total pressure data obtained in constant volume system, Reaction kinetics of enzymatic reactions.

IDEAL REACTORS **12 Hours**

Performance equations: batch, plug flow and mixed flow reactors; Space time and Space velocity; Size comparison of single reactors, multiple reactor systems, Recycle reactor and autocatalytic reactions, Reactors for bioprocess industries.

NON-IDEAL REACTORS **12 Hours**

RTD: Reasons for non-ideality in reactors, RTD function and measurement, RTD in plug flow and mixed flow reactor, Conversion in non ideal flow, relation among E,F and C curve, non - ideal flow models: tank-in-series and dispersion models, Non-ideal models for bioreactors.

HETEROGENEOUS REACTING SYSTEM **12 Hours**

Heterogeneous reacting system: Introduction, Ideal contacting patterns, Solid catalysed reactions: Surface kinetics and pore resistance; Kinetics of non catalytic fluid particle systems: Progressive conversion model and shrinking core model; Determination of rate controlling step, Rate controlling step in adsorption.

INDUSTRIAL REACTORS **12 Hours**

Reactors to carry out G/L reactions on solid catalysts - Trickle bed, slurry, three phase fluidized bed, fluid-fluid and fluid-particle reactors, Multiphase bioreactors.

THEORY: 45 **TUTORIAL: 15** **TOTAL HOURS: 60**

REFERENCE(S):

1. Octave Levenspiel. *Chemical Reaction Engineering*., 3rd edition, Wiley.2014
2. Fogler, H. Scott. *Elements of Chemical Reaction Engineering*. PHI learning private limited, 1999
3. Coulson, John Metcalfe, John Francis Richardson, and Donald George Peacock. *Coulson & Richardson's Chemical Engineering: Chemical & Biochemical Reactors & Process Control*. Vol. 3. Elsevier, 1994
4. Nauman, E. Bruce. *Chemical Reactor Design, Optimization, and Scaleup*. John Wiley & Sons, 2008

OTHER REFERENCE(S):

1. http://nptel.ac.in/courses/103108097
2. http://chemeng.iisc.ernet.in/venu/crenotes.pdf

U15BTT603	BIOPROCESS INSTRUMENTATION AND CONTROL	L	T	P	C
		3	0	0	3

Objective:
To apply the concepts of process control in bioprocess industries.

Course Outcomes (COs):
At the end of the course student will be able to:

CO1 Outline the basic principles of process control in bioprocesses.
CO2 Obtain the knowledge of basic instrumentation.
CO3 Select the measurement technique for a bioprocess system.
CO4 Distinguish various control configurations.
CO5 Differentiate the different types of controllers and final control element.
CO6 Design and apply different control schemes in bioprocess.

Pre-requisite courses:

1 U15BTT401 Concepts of Industrial Biotechnology
2 U15BTT402 Biotechniques
3 U15BTT503 Bioprocess Engineering

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S	W	S							M				
CO2	W	M	S	S					M	M				
CO3		M	M						S	M				
CO4	S	S	M						M	M				
CO5	W	M			M				S	M				
CO6		W			M					M				

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course Content

BIOPROCESS ENGINEERING **4Hours**

Introduction to instrumentation and process control in bioprocesses. Measurement of

physical and chemical parameters in bioreactors.

BASICS OF INSTRUMENATION **5Hours**

Introduction to Instrument specification – accuracy, range, sensitivity, repeatability, readability - resolution – dead time – time constants – residence time – calibration of instruments - off-line Analytical methods – Data logging and data analysis.

ONLINE MEASUREMENTS **10Hours**

Online estimation and monitoring of pH -Temperature – Gas flow rate – liquid flow rate – liquid level - dissolved oxygen -pO_2- pCO_2 – Pressure – Foam – agitator speed – Biosensors - Online sensors for cell properties.

BIO PROCESS CONTROL **10Hours**

Introduction to control systems – open loop and closed loop systems – Servo and regulatory operations – Introduction to application of different control loops in bioprocesses – Feedback, Feed forward, Cascade and Ratio.

ELECTRONIC CONTROLLERS **10Hours**

Elements of Digital computers; Computer Interfaces and peripheral devices - Different types of controller modes- on/off control, P, PI, PID Algorithms – Final control elements – Pneumatic & Electronic Valves & Actuators — Industrial controllers – PLC, SCADA & DCS.

Case Study: Study of design and operation strategies for batch and continuous fermentation processes through simulation software. **6 Hours**

Total Hours :45

REFERENCES

1 T.K.Ghose (Ed.) *"Process Computations in Biotechnology"* (1994), Tata McGraw Hill Publ.Co.,N.Delhi.

2 Stephanopoulous, G., Chemical Process Control: "*An Introduction to Theory and Practice*",Prentice Hall of India 1984

3 Willard, H.H., L. L. Merrit, J. A. Dean and F. L. Seattle, *Instrumental Methods of Analysis*, CBS Publishing Co, New York,2010

4 Harriott, P., "*Process Control*", Tata McGraw Hill.1972.

5 Bailey J.E. and Ollis,D.F. *" Biochemical Engineering Fundamentals"* 2nd Edition, (1986), McGraw Hill Book Co., Singapore

OTHER REFERENCES

1 K. Krishnaswamy, "*Process Control"* New Age International. 2007

2 C.D. Johnson, "*Process Control Instrumentation Technology*" Eastern Economy Edition, 2012

3 K. Sawhney, Puneet Sawhney, *A Course in Electrical and Electronic Measurement sand Instrumentation*, Dhanpath Rai & Co (P) Ltd, 2012

U15GST005	ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT	L	T	P	C
		3	0	0	3

Objectives:

- Acquire knowledge of economics to facilitate the process of economic decision making
- Acquire knowledge on basic financial management aspects
- Develop the skills to analyze financial statements

Course Outcomes (COs)

At the end of the course student will be able to:

After successful completion of this course, the students should be able to:

CO1: Evaluate the economic theories, Cost concepts and pricing policies
CO2: Understand the market structures and integration concepts
CO3: Understand the measures of national income, the functions of banks and concepts of globalization
CO4: Apply the concepts of financial management for project appraisal
CO5: Understand accounting systems and analyze financial statements using ratio analysis
CO6: Design ratio-analysis and evaluate its significance

Pre-requisite:

1. Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1			S								S			
CO2			M											
CO3			S											
CO4											S			
CO5			S						S		S			
CO6			S						M	M				

Course Assessment methods:

Direct		Indirect		
1	Internal Tests	1	Course end survey	

2	Assignments	2	Faculty survey	
3	End semester examination	3	Industry survey	
		4	Alumni survey	

ECONOMICS, COST AND PRICING CONCEPTS 9Hours

Economic theories – Demand analysis – Determinants of demand – Demand forecasting – Supply – Actual cost and opportunity cost – Incremental cost and sunk cost – Fixed and variable cost – Marginal costing – Total cost – Elements of cost – Cost curves – Breakeven point and breakeven chart – Limitations of break even chart – Interpretation of break even chart – Contribution – P/V-ratio, profit-volume ratio or relationship – Price fixation – Pricing policies – Pricing methods

CONCEPTS ON FIRMS AND MANUFACTURING PRACTICES 9Hours

Firm – Industry – Market – Market structure – Diversification – Vertical integration – Merger – Horizontal integration

NATIONAL INCOME, MONEY AND BANKING, ECONOMIC ENVIRONMENT9Hours

National income concepts – GNP – NNP – Methods of measuring national income – Inflation – Deflation – Kinds of money – Value of money – Functions of bank – Types of bank – Economic liberalization – Privatization – Globalization

CONCEPTS OF FINANCIAL MANAGEMENT 9Hours

Financial management – Scope – Objectives – Time value of money – Methods of appraising project profitability – Sources of finance – Working capital and management of working capital

ACCOUNTING SYSTEM, STATEMENT AND FINANCIAL ANALYSIS 9Hours

Accounting system – Systems of book-keeping – Journal – Ledger – Trail balance – Financial statements – Ratio analysis – Types of ratios – Significance – Limitations

TOTAL: 45 HOURS

REFERENCE(S):

1. Prasanna Chandra, " Financial Management (Theory & Practice) TMH
2. Weston & Brigham, " Essentials of Managerial Finance"
3. Pandey, I. M., "Financial Management" Fundamentals of Financial Management- James C. Van Horne.
4. James C. Van Horne, Financial Management & Policy -
5. M. Y. Khan & P. K. Jain Management Accounting & Financial Management-
6. P. Saravanavel Management Accounting Principles & Practice -

U15BTP602	BIOPROCESS ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1

Objectives:

- Provide hands-on training on the operation of fermenters
- To familiarize the students with microbial growth kinetics
- To know mass/heat transfer in fermenters and production of metabolites

Course Outcomes :

At the end of the course student will be able to:

CO1 : Analyze microbial growth in batch, fed-batch and continuous cultivation
CO2 : Analyze and interpret the results of estimation of K_La by different methods
CO3 : Explain medium optimization methods in biotechnology research
CO4 : Demonstrate the production of microbial metabolites
CO5 : Operate the annular centrifugal extractor for the recovery of antibiotics
CO6 : Estimate the heat transfer coefficient in bioreactors

Pre-requisite:

1 U15BTP302 Microbiology laboratory
2 U15BTP502 Enzyme technology laboratory

CO/PO Mapping
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1				M	M					M				
CO2		S	S	S	M				S					
CO3		S	S	S	M				S					
CO4		S	M											
CO5		S			M									
CO6			M		M									

Course Assessment methods:

Direct		Indirect	
1	Continuous assessment & Internal tests	1	Course end survey
2	Semester practical examination	2	Faculty survey
		3	Industry survey
		4	Alumni survey

Course content:

1. Batch sterilization design
2. Batch cultivation with exhaust gas analysis
3. Fed-batch /continuous cultivation with exhaust gas analysis
4. Residence Time Distribution (RTD) studies to find non-ideality of a fermenter

5. Medium optimization by Plackett-Burman design/response surface methodology (RSM) using design expert tool
6. Estimation of K_La – power correlation / sulfite oxidation / dynamic gassing method
7. Production of microbial metabolites (enzymes / antibiotics) in bioreactor
8. Extraction of antibiotics using a separating funnel / annular centrifugal extractor
9. Production of biofertilizers / biopesticides / mushroom
10. Estimation of overall heat transfer coefficient
11. Estimation of mixing time in fermenter

Practical: 45 Hours **Total Hours : 45**

REFERENCES:

1 Sadasivam, S., and Manickam, A. *"Biochemical methods*, 3rd." (2008). New Age International Publisher, New Delhi.

2 Ninfa, A. J., and D. P. Ballou. *"Fundamental lab. approaches for biochemistry and biotechnology*, 2nd." (1998). Oxford University Press, London.

U15BT603	PLANT CELL CULTURE LAB	L	T	P	C
		0	0	4	2

Course Objective(s)

- To gain hands-on training in preparation of plant tissue culture media
- To learn techniques in Explants preparation and regeneration of whole plants from callus
- To develop skills in protoplast isolation and viability staining
- To gain practical knowledge in preparation and preservation of plant cells

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 : Prepare stock solutions and media for plant tissue
CO2 : Preparation of explants from the various plant parts
CO3 : Induction of callus and regeneration of plants
CO4 : Induction of hairy roots for secondary metabolite production
CO5 : Cryopreservation of callus
CO6 : Hardening and release of tissue cultured plants

Pre-requisite courses:

1 U15BTP401 Cell and Molecular Biology Lab

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S		W		S	M			S					
CO2					S									
CO3		M			S									
CO4	S		M		S									
CO5	S				S				S					
CO6					S				S					

Course Assessment methods:			
Direct		Indirect	
1	Continuous Assessments	1	Course end survey
2	Model Practical Examination	2	Industry survey
3	End semester Practical examination	3	Alumni Survey
		4	Faculty survey

Course Content

1. Basic design, lay out, requirement and safety guidelines of plant tissue culture
2. Preparation of stock solutions of MS basal medium and plant growth regulator stocks.
3. Initiation and maintenance of callus culture of carrot / tobacco
4. Micro propagation of Tobacco / Rice / Medicinal plant
5. Initiation of root cultures of tobacco / onion for secondary metabolite production
6. Protoplast isolation, culture and regeneration (Tobacco)
7. Preparation of cell suspension culture (Tabacco / rice/ medicinal plants)
8. Induction of hairy roots for secondary metabolite production
9. Cryopreservation of callus – Conservation of endangered plant species
10. Hardening and field release of tissue cultured plants – Lab to land: Demonstration

Total Hours : 45

Theory: Nil Practical's: 45Hours Total Hours Covered: 45 Hours

REFERENCES:

1 Sant Saran Bhojwani and M. K. Razdan (1996) *Plant tissue culture*: theory and practice; Elsevier science.

2. Reinert, J., and Yeoman, M.M (1982) Plant Cell and Tissue Culture. A Laboratory Manual. Springer-Verlag Berlin Heidelberg

3. Lindsey, K (1997) Plant Tissue Culture Manual - Fundamentals and Applications. Springer Netherlands

WEB REFERENCES:

4. www.biotechnology4u.com/plant_cell_tissue_culture.html

U15GH*P*601/ NATIONAL VALUES	**L**	**T**	**P**	**C**
(Common to all branches of Engineering and Technology)	**1**	**0**	**0**	**1**

Objectives

1. To enlighten students about responsible citizenship and polity
2. To sensitize the greatness of India and Indian Culture and to encourage students to uphold them
3. To be aware of the India's messages to world and propagate them as when possible
4. To understand about the uniqueness of India
5. To know about famous Indian personalities and their characteristics and to know about their contributions

Course outcomes:

At the end of the course student will be able to:

1. The Students shall acquire knowledge on the Enlightened Citizenship.
2. The Students shall know skills the greatness of India and Indian Culture.
3. The students shall be aware of the messages of India to the world
4. The Students shall be aware of the uniqueness of India
5. The students shall know about the inspiring Indian personalities and emulate them

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1		W				M		M				M		
CO2		W				S	W	S	M	M		M		
CO3		W	W		W	M	W	M	M	M		M		
CO4		W				M	W	M	W	W		M		
CO5						W	M	W	W	W		S		

Course Assessment methods:

Direct	Indirect
1.Individual Assignment 2.Group Assignment 3.Presentation 4.Surprise Test 5.Practical Assessment 6.End Semester Assessment	1.Attendance and Behavioural Assessment

Enlightened Citizenship	2 Periods
Greatness of India & Indian Culture	2 Periods
Uniqueness of India	2 Periods
Famous Indian Personalities	2 Periods
India's messages to the world	3 Periods
Meditation & Yogasanas	4 Periods

Total Periods: 15

References Books:

1. Gurcharan Das, "*India Grows at Night*", Penguin Books India, Published September 2012.
2. Swami Vivekananda, "*Prosperous India"* 1st edition, The Ramakirshna Mission Institute of Culture, 1937.
3. Sarvepalli Radhakrishnan, *"The Source Book on Indian Philosophy"*, Princeton, N.J. : Princeton University Press, 1957.
4. Amartya Sen, *"The Argumentative Indian",* Allen Lane, Published 2005.

SEMESTER – VII

U15BTT701	BIOINFORMATICS	L	T	P	C
		3	0	0	3

Objective(s):

- To understand the significance of string alignment
- To construct the phylogenetic tree
- To understand the fundamentals of protein structure prediction and microarray analysis

Course Outcomes :

At the end of the course student will be able to:

CO1 : Explain UNIX commands, various types of network protocols and architecture of biological databases

CO2 : Demonstrate and interpret the biological string matching by dot matrix and dynamic program algorithms

CO3 : Apply, solve, interpret and analyze the heuristics based pairwise sequence analysis of macromolecules through various algorithms

CO4 Apply, solve, interpret and analyze the heuristics based multiple sequence analysis of macromolecules through various algorithms

CO5 : Construct, interpret and assess the different molecular phylogenetic tree prediction and gene prediction algorithms

CO6 : Outline the protein prediction structure algorithms, and microarray construction

Pre-requisite:

1 U15BTT201 Biomolecules and Genetics

2 U15BTT404 Cell and Molecular Biology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M		S	M	W									
CO2	S	S		M	S							M	M	M
CO3	S	S	W	S	S							S	S	S
CO4	S	M		M	S							W	S	S
CO5	S	S	M	M	M							M	S	S

CO6	S	S	M	M	M							M	M	M

Course Assessment methods:			
Direct		**Indirect**	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

NETWORK PROTOCOLS AND BIOLOGICAL DATABASES **9 Hours**

Operating systems: types, UNIX commands; Network Protocols: OSI, TCP/IP, ftp; Introduction to biological databases: Primary nucleotide databases (EMBL, Gene Bank and DDBJ), Primary protein databases (SwissProt, TrEMBL and PIR); EST Database; Genome annotation; Composite protein sequence database: OWL, NRDB; Secondary protein databases (PROSITE, BLOCKS and Profiles); Structural databases: SCOP and CATH.

STRING MATCHINGAND DYNAMIC PROGRAMMING **9 Hours**

Introduction: strings, substrings, identity, similarity, INDEL; Gaps: biological significance, different types of gap penalties; Overview of basic algorithms: Naïve, Boyer – Moore; Algorithm of dot matrix analysis; Introduction to pairwise sequence alignment: global vs. local; Dynamic programming: Needleman – Wunsch algorithm, Smith – Waterman algorithm; Parametric and suboptimal alignments. **Case study:** Impact of signal to noise ratio (SNR) in dot matrix analysis

DATABASE SEARCH ALGORITHMS **9 Hours**

Substitution matrices: PAM, BLOSUM; Position specific scoring matrices (PSSM); Database search algorithms and applications: FASTA, BLAST, PSI BLAST; Algorithm of multiple sequence alignments (msa): Sums of pairs method (SP), CLUSTAL W, PILEUP; Overview of iterative msa methods; SAGA; Expectation – Maximization (EM) algorithm; Machine learning – Hidden Markov models.

MOLECULAR PHYLOGENY ANALYSIS AND GENE PREDICTION **9 Hours**

Molecular Clock theory (old and new); Jukes-Cantor and Kimura's models; Algorithm of distance matrix methods: Unweighted pair group method of arithmetic mean (UPGMA), Fitch-Margoliasch algorithm (FM), Neighbor – Joining method (NJ); Character based methods: Maximum parsimony, maximum likelihood; Bootstrapping technique; Comparative genomics; Prokaryotic and eukaryotic gene prediction methods: Feature and homology based methods.

Case study: Construct of distance matrix table from imaginary biological sequences

STRUCTURE PREDICTION OF PROTEINS **9 Hours**

Microarray analysis: spotted and oligonucleotide arrays; Clustering gene expression profiles: hierarchical clustering, nearest neighboring clustering, unweighted pair group clustering; Algorithm of protein secondary structure prediction: Chow-Fasman method, GOR method, *ab initio* approach, threading method; Systems biology: Introduction to metabolic pathways; Introduction to computer aided drug design (CAD).

Theory: 45 Hr **Total Hours : 45**

REFERENCES:

1 Bergeron, Bryan P. *Bioinformatics computing*. 2nd Edition, Prentice Hall Professional, ISBN: 0-13-100825-0, 2003.

2 Attwood, Teresa K., and David J. Parry-Smith. *Introduction to bioinformatics*. 1st Edition, Prentice Hall, ISBN: 13: 9780582327887, 2003.

3 Rastogi, S. C., Parag Rastogi, and Namita Mendiratta. *Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery*. 4th Edition, PHI Learning Pvt. Ltd., ISBN: 978-81-203-4785-4, 2013.

4 Mount, David W., and David W. Mount. *Bioinformatics: sequence and genome analysis*. 2nd Edition, , Cold Spring Harbor Lab (CHSL) press, USA, ISBN: 0-87969-687-7", 2004.

5 Gusfield, Dan. *Algorithms on strings, trees and sequences: computer science and computational biology*. Cambridge university press, 11th Print" (2008), Online publication (2010).(1997), Book DOI: http://dx.doi.org/10.1017/CBO9780511574931.

OTHER REFERENCES:

1 http://mally.stanford.edu/~sr/computing/basic-unix.html
2 http://www.avatar.se/molbioinfo2001/seqali-dyn.html
3 http://www.clcbio.com/index.php?id=1046
4 http://www.ncbi.nlm.nih.gov/About/primer/phylo.html.
5 http://www.ncbi.nlm.nih.gov/Education/BLASTinfo/BLAST_algorithm.html
6 http://nptel.ac.in/courses.php
7 http://nptel.ac.in/downloads/102103044/
8 http://nptel.ac.in/courses/102103044/pdf/mod6.pdf

U15BTT702	DOWNSTREAM PROCESSING	L	T	P	C
		3	0	0	3

Objective:

- To provide an insightful overview of the fundamentals of downstream processing for bio product

Course Outcomes :

At the end of the course student will be able to:

CO1 : Apply the various unit operation principles to design separation processes specific to biologically produced products

CO2 : Design and analyze the solid-liquid unit operations, cell disruption processes involved in downstream processing

CO3 : Describe the principles underlying the various unit operations for the isolation and extraction of bio-products

CO4 : Select and design the various methods of chromatography used in protein purification

CO5 : Explain of different methods final polishing of bio-products at the industrial level

CO6 : Analyze analytical and process validation issues of final product formulation

Pre-requisite:

1 U15BTT502 Enzyme Technology

2 U15BTT503 Bioprocess Engineering

3 U15BTT504 Heat and Mass Transfer in Bioprocesses

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S	S			S					M		M	W	S
CO2	S	M		S	M					M		M		S
CO3	S	S		S	S					M		M		M
CO4	S	S		S	S					M		M		M
CO5	S	M			S					M		M	W	M
CO6	S	M	W		S					M		M	M	M

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course Content

INTRODUCTION TO DOWNSTREAM PROCESSING AND PRIMARY SEPARATION **9 Hours**

Introduction to Downstream processing principles, classification and Characteristics of Biomolecules; Cell disruption methods for intracellular products release: Mechanical methods, Chemical, physical and enzymatic methods; Unit operations for solid-liquid separation-Filtration, Types of equipments, batch-continuous, pretreatment methods and Centrifugation, Scale-up of centrifugation, centrifugal filtration)

ENRICHMENT OPERATIONS **9 Hours**

Adsorption, Extractive separation: Solvent extraction, Aqueous Two Phase and Three Phase Extractions, Reverse Micelle Extraction, Super Critical Extraction; Precipitation methods: Salts, Organic solvents and polymers, Membrane Based Separation: Ultrafiltration, Microfiltration, Nanofiltration, Reverse Osmosis, Dialysis and Electrodialysis

PRODUCT PURIFICATION **9 Hours**

Chromatographic Principles: Distribution coefficients, retention parameters, qualitative and quantitative aspects of chromatography-Column Efficiency, Selectivity and Resolution. Size exclusion Chromatography, Ion exchange chromatography, Reverse phase chromatography, hydrophobic interaction chromatography (HIC), RP -HPLC Affinity chromatography, isoelectric focusing and its applications.

PRODUCT POLISHING **9 Hours**

Crystallization: Methods of super saturation, types of nucleation and crystal growth, Material and energy balance, yield of crystal, Types of crystallization and equipments. Drying: types of moistures, batch drying process, mechanism of drying, drying time calculation, drying equipments; Freeze-drying, Case study in production polishing

ANALYSIS OF THE FINAL PRODUCT FORMULATION **5 Hours**

Analysis of the final product - Protein-based contaminants, Removal of altered forms of the protein of interest from the product stream, Product potency, Detection of protein-based product impurities: High-pressure liquid chromatography (HPLC), Mass spectrometry, Immunological approaches to detection of contaminants, Amino acid analysis, Peptide mapping, N-terminal sequencing, Analysis of secondary and tertiary structure, Endotoxin and other pyrogenic contaminants, Endotoxin - the molecule, Pyrogen detection, DNA, Microbial and viral contaminants, Viral assays, Miscellaneous contaminants, Validation studies.

FACTOR AFFECTING FINAL PRODUCT FORMULATION **4 Hours**

Factors affecting the biological activity of proteins: Proteolytic degradation and alteration of sugar side-chains, Protein deamidation, Oxidation and disulfide exchange, Stabilizing excipients used in final product formulations, Final product fill, labelling and packing, Case study in purification of industrial important enzymes

Theory:43 Hours **Case study: 2 hours** **Total Hours :45**

REFERENCES:

1 BIOTOL series-Product recovery in Bioprocess Technology VCH publications, 1995

2 Belter P.A, Cussler,E.L and Wei-Houhu , Bioseparations- Downstream Processing for Biotechnology, Wiley Interscience Publications, USA,1988.

3 Roger G.Harrison, Paul Todd, Scott R.Ruger and Demetri P. Petrides, Bioseparation Science and Engineering', oxford University Press, 2nd ed. NewYork, 2009.

4 Sivashankar, B , Bioseparation : Principles and Techniques' Prentice Hall of India, New Delhi, 2005.

5 Jansons. J.C and Ryden L. (Ed), Protein purification-Principles, High Resolution Methods and Application'. VCH Publications,1989.

6 Walsh, Gary. Pharmaceutical biotechnology: concepts and applications. John Wiley & Sons, 2007.

OTHER REFERENCES:

1 Scopes, R.K, Protein Purification – Principles and Practice, 2nd ed. Narosa Publications, 2005

2 Frokjaer, S. and Otzen, D. Protein drug stability: a formulation challenge. Nature Reviews Drug Discovery 4, 298–306, 2005.

3. http://nptel.ac.in/courses/102106022/

U15BTT703	BIOPHARMACEUTICAL TECHNOLOGYAND REGULATORY PRACTICES	L	T	P	C
		3	0	0	3

OBJECTIVE(S):

- To understand the importance of drug control, standard, manufacture process and therapeutic uses

COURSE OUTCOMES :

At the end of the course student will be able to:

CO1 : Outline National, International drug Standards, Control and pharmacopoeia commission

CO2 : Describe the principles of drug action and mechanism of action

CO3 : Discuss and obtain knowledge on the drug development, manufacture process and Regulatory practices

CO4 : Understand the importance of biopharmaceutical final products production using upstream downstream process and ensure the quality of the product analysis

CO5 : Explain the principles and materials involved during the drug manufacture in pharmaceutical industries

CO6 : Discuss the clinical uses of biopharmaceutical therapeutics

PRE-REQUISITE:

1 U15BTT302 Microbiology

2 U15BTT505 Immunology and microbial pathogenesis

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S		M		M								M	
CO2	M		M										M	
CO3	M		S		M									S
CO4			M											S
CO5	M			S										M
CO6	M	S		S									M	

COURSE ASSESSMENT METHODS:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course content

8 Hours

DRUG CONTROL AND STANDARDS

Drug standards, regulation and control organizations: National agencies (Central Drug Standards and Control Organization (CDSCO); Indian Pharmacopoeia commission (IPC); Drugs Controller General of India (DCGI) and Indian Council for Medical Research (ICMR). International agencies (WHO guidelines on medicines policy; Food and Drug Administration (FDA); New Drug Application (NDA); Medicines and Healthcare products Regulatory Agency (MHRA).

7 Hours

PHARMACOKINETICS AND PRINCIPLES OF DRUG ACTION

Route of drug administration: Enteral and parenteral; Pharmacokinetics: Drug Absorption, Distribution, Metabolism and Elimination (ADME); factors influencing ADME process; Pharmacodynamics: basic principles of drug action, Mechanism of drug action through enzymes, drug receptor interactions; radiopharmaceutical

7 Hours

DRUG DEVELOPMENT AND MANUFACTURE PROCESS

New Drug development: Drug discovery, patenting, preclinical and clinical trials, and regulatory authorities; Manufacturing process: special manufacturing facilities, sources of biopharmaceuticals, production of final product and analysis of the final products

7 Hours

REGULATORY PRACTICES

Good manufacturing practices (GMP); Good clinical practices (GCP); Good laboratory practices (GLP); The Drugs & Cosmetics Act, 1940; Schedule M & Y; Applications monitoring quality control; types of validation

9 Hours

PRINCIPLES OF DRUG MANUFACTURE IN PHARMACEUTICALS

Dosage form design: Need for dosage forms, General considerations in Dosage form design; Solid dosage forms: powders, granules, capsules and tablets; Semisolid dosage forms: ointments, creams and gels; transdermal drug delivery system; Pharmaceutical inserts: suppositories and inserts; Liquid dosage forms: solutions; Sterile dosage forms: parenteral (injections), Biologics (vaccine).

7 Hours

BIOPHARMACEUTICAL THERAPEUTICS AND CLINICAL USES

Various categories of therapeutics production and uses: Cytokines: interferons, interlukins, tumour necrosis factor. Haemotopoietic growth factors; Colony stimulating factor (granulocyte, macrophage), erythropoietin; Hormones: insulin, glucagons.

Theory:45 Hours **Total Hours :45**

REFERENCES:

1 Harvey, R.A., Clark, M.A., Finkle, R., (2011), Pharmacology (Lippincott Illustrated Reviews Series, LWW Publishers, 5th Ed.,

2 Katzung, B., Masters, S., Trevor, A., (2009), Basic and Clinical Pharmacology (LANGE Basic Science), McGraw-Hill Medical, 11th ed.,

3 Ansel H.C., et al. (2007) Pharmaceutical dosage forms and drug delivery systems- 8th edition, Lippincott Williams & Wilkins.

4 Richard D. Howland. (2007) Lippincott's illustrated reviews: Pharmacology. 7th Edition, Lippincott Williams & Wilkins.

5 Remington (2000) Pharmaceutical sciences, 20th edition, Mack publishing and Co., PA

6 Troy, D. B (2006) Remington: the Science and practice of Pharmacy, 21st edition. Vol I &II., Lippincott Williams &wilkins., New York.

5 Gary Walsh. (2005) Biopharmaceutical technology-biochemistry and biotechnology, 1st Edition, John Wiley and Sons, Ltd.

OTHER REFERENCES

1 http://ocw.mit.edu/courses/health-sciences-and-technology/hst-151-principles-of-pharmacology-spring-2005/lecture-notes/

2 http://onlinelibrary.wiley.com/book/10.1002/9780470259818

U15BTT704	BIOREACTOR MODELLING AND SIMULATION	L	T	P	C
		3	0	2	4

Objective:

- To enable the students understand the fundamental aspects of modeling and simulation of various biological systems

Course Outcomes :

At the end of the course student will be able to:

CO1 : Apply the fundamentals of modeling and kinetics in bioprocess system
CO2 : Illustrate the principles of reactor design for immobilized system
CO3 : Understand the non- ideal behavior in bioreactor
CO4 : Application of various models in bioprocess engineering
CO5 : Apply the principles of simulation techniques using simulation software
CO6 : Develop the flow sheet for various bioprocess operation

Pre-requisite:

1 U15BTT503 Bioprocess Engineering
2 U15BTT603 Bioprocess Instrumentation and control
3 U15BTT601 Chemical Reaction Engineering

CO/PO Mapping
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S	M								M		M		M
CO2	S	S								M		M		S
CO3	S	S			S					M		M		S
CO4	S			M						M		S		M
CO5	S	M		M						M		S		M
CO6	S			M	S					M		M		M

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course content

REACTION KINETICS IN BIOREACTORS **9 Hours**

Modeling Principles, model development. Modeling approaches for biological systems – structured and unstructured systems; Compartment models; Deterministic and stochastic approaches for modeling structured systems, Case study: Introduction to process flowsheeting and simulation

9 Hours

BIOREACTOR DESIGN FOR ENZYME REACTION AND IMMOBILISED CELLS

Heterogeneous reaction; Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions, formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized packed bed, fluidized bed and membrane reactors, Case study: Material Balance with Reaction using superpro designer; Modeling and simulation of human insulin production using super pro.

9 Hours

MODELING OF BIOREACTORS

Bioreactor modeling: Ideal and non-ideal bioreactors; Stirred tank models; characterization of mass and energy transfer distributions in stirred tanks, Tower Reactor Model; Flow modeling, mass transfer modeling, Models for mass transfer in tower reactors, process models in tower reactors.

9 Hours

LINEAR SYSTEM ANALYSIS

Study of linear systems in bioprocess engineering, linearization of non-linear systems; Simulation of linear models using MATLAB; Parameter estimation and sensitivity analysis; Steady state and unsteady state systems;. Case studies: Solving linear and polynomial equations using MATLAB

9 Hours

DYNAMIC SIMULATION

Introduction to various simulation softwares. Dynamic simulation of batch, fed-batch steady and transient culture metabolism, Case studies: Modeling of Batch, Fed Batch and Continuous using Berkeley Madonna software, Case studies: Modeling and simulation of human insulin production using super pro designer.

Theory:45 Hours **Tutorial/Practical : 15 Hours** **Total Hours :60**

REFERENCES:

1 Tapobrata Panda, "Bioreactors Analysis and Design", New Delhi: Tata McGraw Hill.2011.

2 Biquette W.B. "*Process Dynamics- Modeling analysis with simulation",* Prentice Hall; 1 edition January 15, 1998.

3 Volesky, Bohumil, and Jaroslav Votruba. *Modeling and optimization of fermentation processes*. Elsevier, 1992.

4 Dunn, Irving J., et al. *Biological reaction engineering*. VCH, Weinheim New York Basel Cambridge, 1995.

5 Michael, L. Shuler, and Fikret Kargi. "Bioprocess engineering: basic concepts." (1992). 2nd Edition, New Delhi, Prentice-Hall of India. 2012.

6 Luyben, William L. *Process modeling, simulation and control for chemical engineers*. McGraw-Hill Higher Education, 1989.

OTHER REFERENCES:

1 Nauman, E. Bruce, "Chemical Reactor Design, Optimization, and Scale up", New Delhi: Tata McGraw Hill. 2002

2 Demetri Petrides, (2003) SuperPro Designer, Intelligen Inc.,

	COMPREHENSIVE STUDIES	L	T	P	C
		0	0	0	0

U15BTP701	BIONFORMATICS LABORATORY	L	T	P	C
		0	0	3	1

Objective(s):

- To understand, perform and interpret the pairwise sequence & multiple sequence alignment analysis
- To acquire skill in the construction of phylogenetic trees and to learn the basics of gene prediction methods
- To perform and gain experience in microarray analysis, docking techniques & PERL programming

Course Outcomes :

At the end of the course student will be able to:

CO1 : Replicate the retrieval of the macromolecular sequences from different databases and analysis their properties

CO2 : Perform the macromolecular pairwise sequence alignment using dot matrix, dynamic program and heuristics based methods

CO3 : Perform the macromolecular multiple sequence alignment using heuristics based method

CO4 : Perform the molecular phylogenetic tree and correlate the similarity

CO5 : Demonstrate the microarray analysis and ligand-protein docking

CO6 : Execute the simple PERL programs

Pre-requisite:

1 U15BTT201Biomolecules and Genetics

2 U15CSP211 Computing Laboratory

3 U15BTP401 Cell and molecular biology laboratory

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2

CO1	S	S		S	S					M		S	M	M
CO2	S	M		M	S					M		M	M	M
CO3	S	S	M	S	M					M		M	S	S
CO4	S	M	M	M	S					M		S	S	S
CO5	S	M	S	S	S				S	M		W	M	S
CO6	S	M		M	S				S	M		S		

Course Assessment methods:			
Direct		**Indirect**	
1	Continuous assessment	**1**	Course end survey
2	Model examination	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

EXPERIMENTS:

1. Biological Databanks – Retrieval and annotation of macromolecular sequences and structures from the biodatabases
2. String matching and similarity analysis – Dot matrix method and Dynamic programming (EMBOSS)
3. Database search and sequence similarity analysis – FASTA, BLAST and PSI-BLAST
4. Multiple sequence alignment using CLUSTAL W or CLUSTAL OMEGA or MULTALIN
5. Molecular phylogeny analysis using PHYLIP or NCBI tools or EBI tools
6. Protein sequence analysis using ExPAsY
7. Gene prediction - GENSCAN
8. Molecular visualization of protein structure using RASMOL
9. Microarray analysis
10. Protein – ligand docking
11. Sequence analysis using Perl programming

Theory: Nil **Practical: 45 Hours** **Total Hours : 45**

REFERENCES:

1 Mani, K., and N. Vijayaraj. *Bioinformatics a Practical Approach*. Aparna Publications,

India, 2004.
2 Baxevanis, Andreas D., and BF Francis Ouellette. *Bioinformatics: a practical guide to the analysis of genes and proteins*. Vol. 43. John Wiley & Sons, 2004.

OTHER REFERENCES:

1 http://www.ncbi.nlm.nih.gov/
2 http://www.ebi.ac.uk/
3 http://web.expasy.org/docs/swiss-prot_guideline.html
4 http://www.expasy.org/
5 http://genes.mit.edu/GENSCAN.html
6 http://www.bioinformatics.nl/cgi-bin/emboss/dotmatcher
7 http://pe-iitb.vlabs.ac.in

U15BTP702	DOWNSTREAM PROCESSING LABORATORY	L	T	P	C
		0	0	3	1

Objective:
To develop skills to perform the various purification techniques used in biotechnology

Course Outcomes :
At the end of the course student will be able to:

CO1 **:** Apply the principles of various cell lysis methods in downstream processing
CO2 : Illustrate the solid-liquid unit operation involved in downstream processing
CO3 : Apply the principles of different unit operations for the isolation and extraction of bio-products
CO4 **:** Apply the various chromatography method used in protein purification
CO5 **:** Assessing purity of enzyme(s)/protein(s) by SDS-PAGE
CO6 **:** Perform and analysis of HPLC and GC

Pre-requisite:

1 U15BTP502 Enzyme technology Laboratory
2 U15BTP601 Bioprocess Engineering Laboratory

CO/PO Mapping) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSPO1**	**PSPO2**
CO1	S	W			M							M		M
CO2	S	W			M							M		M
CO3	S	W			M				M			M		M
CO4	S	W			M				M			M		S
CO5	S				M				M			M		M
CO6	S	W			M				M			M	M	M

Continuous Assessment methods:

Direct		Indirect	
1	Continuous Assessment	**1**	Course end survey
2	End semester practical examination	**2**	Faculty survey
		3	Industry survey
		4	Alumni survey

Course Content

1. Isolation of biomolecues using Aqueous two phase/three phase extraction
2. Solid -liquid separation by microfiltration
3. Enzyme concentration by ultra filtration
4. Partial purification of enzymes using cell disruption techniques and salt precipitation
5. Purification of His-tagged proteins using on Ni-Column
6. Purification of enzymes using Ion-exchange chromatography
7. Protein purification using gel-filtration chromatography.
8. Assessing purity of enzyme(s)/protein(s) by SDS-PAGE
9. Freeze-drying of yeast cultures
10. Detection of biomolecues using High performance liquid chromatography (HPLC)
11. Quantification of volatile compounds in samples using gas chromatography.

Theory:Nil **Practical: 45 Hours** **Total Hours :45**

REFERENCES:

1 Roger G. Harrison, Paul W. Todd, Scott R. Rudge and Demetri Petrides, Bioseparations Science and Engineering, Oxford University Press, USA, (2002)

2 Robert K.Scopes, *Protein Purification: Principles and Practice*, IIIrd edition, Springer-verlag New York, USA, (2010).

3 Rosenberg (Ian M) , *Protein Analysis and Purification, Bench top techniques*, II[nd] edition, Springer International, New Delhi, India, (2003)

U15BTP703	Project (Phase I)	L	T	P	C
		0	0	4	2

Objective: To develop skills to identify and find solutions to various problems using biotechnology.

Course Outcomes :
At the end of the course student will be able to:

CO1 : Ability to survey literature relevant to the topic under consideration
CO2 : Design a research problem using sound scientific principles
CO3 : Conduct experiments with suitable controls and safety considerations
CO4 : Perform statistical operations and analyze results
CO5 : Interpret results and derive new information
CO6 : Present and communicate results to a scientific audience

Pre-requisite: All core theory and lab courses

CO/PO Mapping)
S-Strong, M-Medium, W-Weak

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSPO1	PSPO2
CO1		S											
CO2			S										
CO3			S		S				S				
CO4													
CO5								M					
CO6					S					S			

Continuous Assessment methods:

Direct		Indirect	
1	Continuous assessment	**1**	Course end survey
2	Viva-voce examination	**2**	Faculty survey
		3	Industry survey
		4	Alumni survey

Course content:
Student in discussion with the guide chooses to design and carry out a novel research problem

U15GHP701/ GLOBAL VALUES	L	T	P	C
(Common to all branches of Engineering and Technology)	**1**	**0**	**0**	**1**

Objectives

1. To facilitate Students to think holistically
2. To empathize ecology and its benefits and thereby conserve it
3. To be aware of issues related to globalisation and how to mitigate it
4. To understand global economy and to know how economy driven world impacts happiness

Course outcomes:

At the end of the course student will be able to:

1. The Students shall understand importance of ecology and its preservations
2. The Students shall understand the various global issues and their causes and solutions
3. The Students shall approach any problem holistically as against giving a reductionist solution
4. The Students shall learn impact of globalization on various factors such as environment, local population etc
5. The Students shall learn to integrate and understand how an Individual peace impacts world peace

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1		W					M	M	M	M		M		
CO2		W				M	S	S	M	M		M		
CO3		W	W		W	M	M	M	W	W		M		
CO4		W				S	M	M	W	W		M		
CO5						W	W	W				S		

Course Assessment methods:

Direct	Indirect
1.Individual Assignment 2.Group Assignment 3.Presentation 4.Surprise Test 5.Practical Assessment 6.End Semester Assessment	1.Attendance and behavioural assessment

Introduction to Global Values	1 Period
Introduction to Systems Thinking	1 Period
Ecology, ecological imbalances and its solution	3 Periods
Globalisation Vs Localisation – an economic and Spiritual Perspective	3 Periods
Global Issues & Solutions	3 Periods
Advanced Contemplative Practices	4 Periods

Total Periods: 15 Hours

References Books:

1. Vethathiri's Maharishi's, *"World peace"* The World Community Service Centre, Vethathiri Publications, 1957.
2. Fritz Schumacher, *"Small is Beautiful",* The Blond & Briggs, Published 1973.
3. Noam Chomsky, *"Profit over People",* Seven Stories Press, Published 1999.
4. Vethathiri's Maharishi's, *"Atomic Poison"* The World Community Service Centre, Vethathiri Publications, 1983.

SEMESTER VIII

U15BTP801	**Project (Phase II)**	**L**	**T**	**P**	**C**
		0	**0**	**18**	**10**

Objective: To develop skills to identify and find solutions to various problems using biotechnology.

Course Outcomes : At the end of the course student will be able to:

CO1 : Ability to survey literature relevant to the topic under consideration
CO2 : Design a research problem using sound scientific principles
CO3 : Conduct experiments with suitable controls and safety considerations
CO4 : Perform statistical operations and analyze results
CO5 : Interpret results and derive new information
CO6 : Present and communicate results to a scientific audience

Pre-requisite: All core theory and lab courses

CO/PO Mapping)
S-Strong, M-Medium, W-Weak

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSPO1	PSPO2
CO1		S											
CO2			S										
CO3			S		S				S				
CO4													
CO5								M					
CO6					S					S			

Continuous Assessment methods:

	Direct		Indirect
1	Continuous assessment	**1**	Course end survey
2	Viva-voce examination	**2**	Faculty survey
		3	Industry survey
		4	Alumni survey

Course content:
Student in discussion with the guide chooses to design and carry out a novel research problem

ELECTIVE- I

U15BTE101	MOLECULAR PLANT BREEDING	L	T	P	C
		3	0	0	3

Objective(s):

- To learn the fundamentals of plant breeding tools
- To learn plant genetic manipulation and their ethical issues.

Course Outcome(s):

At the end of the course student will be able to:

CO1 : Explain the basics of plant breeding programs.
CO2 : Distinguish the mitochondrial genome and chloroplast genome.
CO3 : Outline and learn gene manipulation in plants.
CO4 : Apply the techniques for development of Hybrids, screening and selection procedure
CO5 Apply the techniques in production of Cybrids
CO6 : Describe GM crops and their ethical issues.

Pre-requisite:

1 U15BTT404 Cell and Molecular Biology
2 U15BTT501 Genetic Engineering and Genomics

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S													
CO2	S	S	W		M									
CO3		M			S	W							M	
CO4		M	W		S								M	
CO5		S			M	W						M	M	
CO6		S			M	W						M	M	

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course Content

PLANT GENOME AND ORGANIZATION **9 Hours**

Molecular and classical genetics in modern agriculture; plant genomes- the organization and expression of plant genes; Concept of genetic selection; Chloroplast and Mitochondria genome- Organization and gene expression.

CONCEPTS IN PLANT BREEDING **9 Hours**

History- Mendelian principles; concept of Green revolution; conventional practices for plant production; Selective and cross plant breeding programs; Plant breeder rights; classical genetic improvement- **case study**

PLANTS IMPROVEMENT **9 Hours**

Improvement of crop yield and quality; Molecular markers for crop improvement; application in agriculture and food industries; Transgenic plants- biotic and abiotic stress development.

PLANT BREEDING TECHNIQUES **9 Hours**

Plant breeding tools; concept of Hybrid, cybrid-procedure and establishment; screening and selection of hybrids; Concept of Male sterility- CMS, GMS, CGMS; Importance of plant breeding programme.

GM CROPS AND ETHICAL ISSUES **9 Hours**

Gene manipulation and their impacts on Environmental, cultural, ethical and socioeconomical issues; Release of GMO's; In India, Role of IBSC (RCGM and GEAC); GM crops- Current status and concern about GM crops; Regulation of GM crops and products- for GMOs consumer acceptance in various varieties.

Theory: 45 Hours **Practical: Nil** **Total Hours :45**

REFERENCES:

1 Harvey Lodish, Arnold Berk, S.L Zipursky, Paul Matsudaira, David Baltimore and James Danell *Molecular Cell Biology*, 4th Edition, New York: W.H Freeman and company,2002.

2 Singh, B.D. (2008) *Text book of Biotechnology*, fourth Edition, Kalyani Publishers, New Delhi.

3. Keshavachandran R and Peter KV (2008). Plant Biotechnology- Methods in tissue culture and gene transfer, University press, Hydrabad, India

4 Brown TA., Genomes 2, 3rd edition Bios Scientific Publishers Ltd, Oxford, 2006.

OTHER REFERENCES:

1. http://www.monsanto.com/improvingagriculture/pages/modern-breeding-techniques.aspx
2. http://www.biologydiscussion.com/plants/plant-breeding-steps-and-methods-of-plant-breeding-for-disease-resistance/1340

U15BTE102	FOOD QUALITY AND SAFETY ASSURANCE	L	T	P	C
		3	0	0	3

Objectives:

- To learn about food quality
- To understand the safety aspects in food processing

Course outcomes:

At the end of the course student will be able to:

CO1 : Explain the important parameters of food quality.

CO2 : Discuss the quality policy and identify the hazards in food industries.

CO3 : Describe the general principles of food safety

CO4 : Explain food law and standards

CO5 : Discuss about various international bodies involved in food standards

CO6 : Explain the national standards for foods

Pre-requisite courses:

1 U15BTT301 Concepts in Biochemistry
2 U15BTT302 Microbiology
3 U15BTT403 Food Process Engineering

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M					S				M			S	
CO2	S												S	
CO3			S	W									S	
CO4			S			S							S	
CO5			M			S								
CO6										M		M		

Course Assessment Methods:			
Direct		**Indirect**	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

BASICS OF FOOD QUALITY **12 Hours**

Quality factors: appearance, size and shape, texture : measuring texture, consistency, flavour, taste Panels; Food related hazards: biological hazards, chemical hazards, physical hazards; microbiological considerations in food safety; food additives : preservatives-class I and II, antioxidants, sequestrants, surface active agents, stabilizers and thickeners, bleaching and maturing agents, starch modifiers, buffers, acids, alkalis, food colours, artificial sweeteners, nutritional additives, flavouring agents.

6 Hours

FOOD SAFETY AND HYGIENE

Principles of food safety and quality: food safety system, quality attributes, total quality management; introduction to risk analysis, risk management, risk assessment; good hygienic practice(GHP), good agricultural practice(GAP), good manufacturing practice(GMP),principles and implementation of hazard analysis critical control point (HACCP),case study : Food safety.

9 Hours

FOOD SAFETY REGULATION AT NATIONAL LEVEL

Food laws: Federal Food Drug and Cosmetic Act (1938), Good Manufacturing Practices (Code of GMP), Fair Packaging and Labeling Act (1966), Federal Meat Inspection Act (1906), International Food, Standards and Codex Alimentarius, HACCP and ISO 9000 series, Case study: HACCP.

9 Hours

NATIONAL STANDARDS AND GUIDELINES

PFA, FPO, FSSAI, MMPO, MPO, AGMARK, BIS, Environment and Pollution Control Board, Factory Licence; International food standards; trends in food standardization: an overview and structure of 9001:2000/2008, ISO 9001:2000, overview and structure of 22000:2005, ISO 22000:2005,

9 Hours

INTERNATIONAL BODIES DEALING IN STANDARIZATION

International Standardization Organization (ISO), Joint FAO/WHO Food Standards Program; Codex Alimentarius Commission (CAC), Other International Organizations Active in Food Standard Harmonization. Advantages of Utilizing International Standards.

Theory: 43 Hour **Tutorial /Practical/Case study:-2** **Total Hours Covered:45**

REFERENCES:

1 Fortin, Neal D. *Food regulation: Law, science, policy, and practice*. John Wiley & Sons, 2011.

2 Khanna, Sri Ram, and MadhuSaxena. *Food standards and safety in a globalised world: the impact of WTO and Codex*. New Century Publications, 2003.

3 Malik, A., Erginkaya, Z., Ahmad, S., &Erten, H.*Food processing: strategies for quality assessment*. Springer, 2014.

4 Prem Kumar Jaiswal.Quality and Safety CBS Publishers & Distributors,2009.

OTHER REFERENCES:

1 Alli, Inteaz. *Food quality assurance: Principles and Practices*. CRC Press, 2003.
2 http://www.fao.org/docrep/meeting/019/k6993e.pdf

U15BTE103	FORENSIC BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn concepts relating to forensic science and toxicology
- To understand the concepts of biological evidence collection, and methods [to identify criminals

COURSE OUTCOMES :

At the end of the course student will be able to:

CO1 **:** Describe the basis of forensic science and chemistry
CO2 **:** Recognize the mechanism of toxicology as applied to forensic science
CO3 **:** Illustrate the concept of biological evidence collection and analysis
CO4 **:** List the basic methods of body fluid analysis
CO5 **:** Apply the different methods of enzyme analysis
CO6 **:** Enumerate the role of biotechnology in resolving legal disputes

PRE-REQUISITE:

1 U15BTT301 Concepts in Biochemistry
2 U15BTT402 Biotechniques
3 U15BTT501Genetic engineering

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S		S			M								
CO2			S										S	
CO3						S								
CO4			M			S								
CO5			S			S								M
CO6			S			S								

COURSE ASSESSMENT METHODS:

Direct		Indirect	
1	Internal Tests	1	Course end survey

2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry
		4	Alumni

Course Content

SCOPE OF FORENSIC SCIENCE **6 Hours**

History and Development of Forensic Science, Definition of Forensic Science, Scope of Forensic Science, Need of Forensic Science, Basic Principles of Forensic Science, Tools and Techniques of Forensic Science.

FORENSIC CHEMISTRY **7 Hours**

Types of cases which require chemical analysis, Limitations of forensic samples, conventional methods of chemical analysis, presumptive tests (colour/spot tests), Microcrystal tests, Elemental analysis (organic and inorganic). Examination of contact Traces: Introduction to cosmetics and detective dyes, collection, sampling and analysis.

FORENSIC TOXICOLOGY **8 Hours**

Introduction, Role of the toxicologist, significance of toxicological findings, poisons, definition, classification on the basis of their origin, physiological action and chemical nature, poisons and poisoning in India, Management of Toxicological cases in the hospital - Signs and symptoms of common poisons, antidotes. Collection and preservation of viscera for various types of poisons: Choice of preservatives, containers and storage.

BIOLOGICAL EVIDENCE **6 Hours**

Importance, nature, location, collection and evaluation. Hair and Fibres: Importance, nature, location, collection, evaluation and tests for their identification. Importance and identification of Botanical evidence as Pollen grains, wood, leaves and seeds.

BLOOD SAMPLING AND ANALYSIS **6 Hours**

Blood: Composition and functions, collection and species identification. Human Blood groups: General Principles, theory of their inheritance, Blood group determination from fresh blood, titer, raulax formation and Bombay blood group. Blood grouping from stains of blood, semen, saliva and other body fluids by Absorption-inhibition, Absorption-elution and mixed agglutination techniques, determination of secretor/non-secretor status.

BODY FLUIDS AND ENZYME ANALYSIS **7 Hours**

Semen: Forensic significance, location, collection, evaluation and tests for identification

Forensic significance of other body fluids as saliva, sweat, milk etc. Their collection and identification Polymorphic enzymes: Forensic significance, identification from fresh blood and stains.

PATERNITY DISPUTES AND BIOTECHNOLOGY **5 Hours**

Paternity disputes: Causes, Various serological and biochemical methods, calculation of paternity index and probability for paternity and maternity.

Theory: 45 Hours **Total Hours : 45**

REFERENCES:

1 Modi, Jaising Prabhudas. *Modi's textbook of medical jurisprudence and toxicology*. NM Tripathi, 1969

2 Roberts, John Alexander Fraser, and Marcus E. Pembrey. *An introduction to medical genetics*. London: Oxford University Press, 1963..

3 Jaiswal,AK, Mill, Tabin Handbook of Forensic Analytical Toxicology, Jaypee Brothers Medical Publishers (P) Ltd. 2014

4 Dikshit, P. C. *Textbook of forensic medicine and toxicology*. Peepee Publishers & Distr, 2007.

OTHER REFERENCES:

1 http://www.istl.org/03-spring/internet.html

2 http://www.nist.gov/forensics/resources.cfm

3 http://staff.lib.msu.edu/harris23/crimjust/forsci.htm

U15BTE104	**NEUROBIOLOGY AND COGNITIVE SCIENCES**	**3**	**0**	**0**	**3**

OBJECTIVES

- To learn about the neuroanatomy and neurophysiology
- To understand the concept of synaptic transmission and mechanism of action of neurotransmitters
- To know about the basic mechanisms of sensations and disorders related to nervous system.

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 **:** Outline the basis of central and peripheral nervous system and describe the structure of neurons and supporting cells.

CO2 **:** Discuss the mechanism of action potential conduction and working of voltage dependent channels.

CO3 **:** Illustrate the concept of synaptic transmission and mechanism of action of neurotransmitters.

CO4 **:** List the basic mechanisms of sensations and skeletal muscle contraction.

CO5 **:** Enumerate the mechanisms associated with motivation behaviours.

CO6 Describe the various disorders of nervous system

Pre-requisite courses:

1 U15BTT301 Concepts in Biochemistry

2 U15BTT404 Cell and Molecular Biology

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak All (Font size 12, Times New Roman, align Text center)														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSPO1**	**PSPO2**
CO1	S		S			M								
CO2	S			M										
CO3	S					S							W	
CO4	S		M			S						S	W	
CO5	S		S			S							M	
CO6	S			M		S						S	S	

Course Assessment methods:			
Direct		**Indirect**	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

Hours

NEUROANATOMY **9 hours**

Overview of central and peripheral nervous system, Neurons: structure, types and functions; Glial cells: types; Synapses: types and functions; Myelination; Blood Brain barrier; Neural Development; Cerebrospinal fluid: origin and composition; Spinal cord: functions.

9 hours

NEUROPHYSIOLOGY

Resting and action potential; Properties and mechanism of action potential conduction; Voltage dependent channels: sodium and potassium channels; Electrical transmission; information representation and coding by neurons.

Case study – Neural coding

9 hours

NEUROPHARMACOLOGY

Synapse formation; Synaptic transmission: Principles of Chemical synaptic transmission, neurotransmitters and their mechanism of action: acetyl choline, serotonin and dopamine; Nicotinic and muscarinic acetyl choline receptors; Transmitter gated channels; hypothalamic control of neuronal function.

9 hours

APPLIED NEUROBIOLOGY

Basic mechanisms of sensations: touch, pain, smell, taste; neurological mechanisms of vision and audition; skeletal muscle contraction (neuromuscular junction).

9 hours

BEHAVIOURAL SCIENCE

Basic mechanisms associated with motivation; regulation of feeding, sleep, hearing and memory; Disorders associated with nervous system: Parkinson's disease, Alzheimer's disease, Schizoprenia, Epilepsy; Anxiety and mood disorders: Depression, Agrophobia.

Case study – Degenerative diseases of the nervous system

Total Hours : 45

Theory: 43Hours **Case study: 2Hours** **Total Hours Covered: 45**

REFERENCES:

1 Mark F. Bear, Barry W. Connors and Michael A. Paradiso (2001). *Neuroscience – Exploring the Brain*, 2nd edition, USA, Lippincott Williams & Wilkins.

2 Mathews G G. (2000). *Neurobiology*, 2nd edition, UK, Blackwell Science.

WEB REFERENCES:

3 https://ocw.mit.edu › Courses

		L	T	P	C
U15BTE105	**SYSTEMS BIOLOGY**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To learn and understand the fundamentals of systems modeling and simulation biochemical pathways.

COURSE OUTCOMES (COS):

At the end of the course student will be able to:

CO1 **:** Explain the fundamentals of systems modeling
CO2 **:** Demonstrate the modeling of biochemical networks
CO3 **:** Explain the kinetic models pertaining to cell – cell interactions
CO4 **:** Model large genomic and cellular data
CO5 **:** Simulate biochemical pathways
CO6 **:** Simulate whole cells

PRE-REQUISITE:

1 U15BTT301 Concepts in Biochemistry
3 U15BTT404Cell and Molecular Biology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S			M								M		
CO2	S			S								M		
CO3	S			S								M	S	
CO4	S			S								M		
CO5	S			S								M	S	
CO6	S											S		

COURSE ASSESSMENT METHODS:

	Direct		Indirect
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry
		4	Alumni

Course Content

INTRODCUTION **9 Hours**

Introduction - System-level Understanding of Biological Systems - Advanced Measurement; Systems Modeling Genetic Networks

MODELLING NETWORKS **9 Hours**

Modeling the Activity of Single Gene - A Probabilistic Model of a Prokaryotic Gene and its Regulation Modeling Biochemical Networks - Atomic - Level Simulation and Modeling of Biomacromolecules

KINETIC MODELS **9 Hours**

Kinetic Models of Excitable Membranes and Synaptic Interactions - Stochastic Simulation of Cell Signaling Pathways -Analysis of Complex Dynamics in Cell Cycle Regulation.

ADVANCED MODELLING NETWORKS **9 Hours**

Modeling Large Biological Systems from Functional Genomic Data: Parameter Estimation - Cellular Simulation - Towards a Virtual Biology Laboratory - Computational Cell Biology :The Stochastic Approach

COMPUTATIONAL SIMULATION **9 Hours**

Computer Simulation of the Whole Cell - Computer Simulation of the Cell: Human Erythrocyte Model and its Application - Software for Modeling and Simulation – E-CELL, V- CELL and GROMOS

Theory:45 Hours Tutorial /Practical: Nil Total Hours Covered:45

REFERENCES:

1 Foundations of Systems Biology, Hiroaki Kitano (Editor),MIT Press, 2001

2 Computational Modeling of Genetic and Biochemical Networks, James M. Bower, Hamid Bolouri, MIT Press, 2000.

3 Gene Regulation and Metabolism: Postgenomic Computational Approaches, Julio Collado-Vides (Editor), Ralf Hofestadt (Editor),MIT Press,2002

U15BTE106	IPR AND BIOBUSINESS MANAGEMENT	L	T	P	C
		3	0	0	3

Objectives:

- To provide knowledge on various aspects of intellectual property
- To learn procedures for patenting
- To learn concepts of biobusiness

Course Outcomes :

At the end of the course student will be able to:

CO1 : Explain different forms of Intellectual property.

CO2 : Distinguish different types of patents and patenting system in India.

CO3 : Attain basics fundamentals in field of biobusiness

CO4 : Explain different market approval procedure in India

CO5 : Understand group project presentation.

CO6 : Learn marketing survey and gap finding for business development

Pre-requisite:

1 U15GST006 Product design and development

2 U15BTT401 Concepts of Industrial Biotechnology

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S													
CO2	S	S	W		M									
CO3		M			S	W								
CO4		M	W		S									
CO5		S			M	W						M		
CO6		S			M	W						M		

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course content

INTELLECTUAL PROPERTY RIGHTS **9 Hours**

Significance and types of IP- Patents, Trademarks, Copyright, Industrial Designs, Trade Mark, Trade secret and Geographical Indications; Objective and functions of GATT, WTO, WIPO and TRIPS; Farmers rights.

PATENT SYSTEM IN INDIA **9 Hours**

Indian Patent Act 1970- Recent Amendments; Types of patents; Role of a Country Patent office; Patent applications-Forms and guidelines, fee structure, time frames; Types of patent application; Patent specification - provisional and complete specification; Patent databases-India, USPTO, and EPO; Patent infringement – Turmeric, Neem etc.,

INTRODUCTION TO BIOBUSINESS **9 Hours**

Bio-business – Introduction; Demand and market potential in India; Agri-biotech products with examples; Role of innovation in business development. Basics of Economics- Macro and Micro economics, Concept of Breakeven Point.

BIOBUSINESS OPPORTUNITY AND ISSUES - CASE STUDY **9 Hours**

Biobusiness opportunity area - Health care, Biomedical science, Agricultural Biotechnology, Environmental Biotechnology; Issues and challenges- Cultural, ethical, social and economical issues.

GROUP PROJECT SURVEY AND PRESENTATION **9 Hours**

Preparation of business plan; Project survey, Gap finding market potential analysis; Case studies of different biotech based industries and their strategic planning for marketing.

Theory: 45 Hours **Practical : Nil** **Total Hours : 45**

REFERENCES:

1 Deepa Goel and Ms Shomini Parashar , (2013), IPR, Biosafety and Bioethics, Pearson Education publisher

2 Shaleesha A. Stanley, (2007) 'Bioethics' Wisdom educational service, Chennai.

3 Erbisch, FH and Maredia, KM (1998) Intellectual property rights in agricultural biotechnology Universities Press (India) Ltd.

4 Singh. K, (2010) "Intellectual Property Rights in Biotechnology" BCLI, New delhi.
Rajiv Jain and Rakhee Biswas,(1999) Law Of Patents, Procedure & Practice,Vidhi

5. Publication

OTHER REFERENCES

1.http://www.ipindia.nic.in/ipr/patent/patents.htm

2. http://ipindia.nic.in/ipr/patent/journal_archieve/journal_2013/patent_journal_2013.htm

3. http://www.biobusinessmag.com/

4. http://www.the-scientist.com/?articles.list/categoryNo/2926/category/Bio-Business/

ELECTIVE- II

U15BTE201	FOOD BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Objective(s):

- To learn about food and nutrients
- To understand the role and importance of functional foods

Course outcomes :

At the end of the course student will be able to:

CO1 : Describe the relationship between food and nutrients.
CO2 : Explain the role of functional foods and nutraceuticals in the promotion of human health and nutrition.
CO3 : Discuss the advantages and disadvantages of probiotics and prebiotics.
CO4 : Describe students to modify foods using biotechnology.
CO5 : Explain the strategies to produce specific food ingredients.
CO6 : Discuss the technologies for improving processes

Pre-Requisite:

1 U15BTT302 Microbiology
2 U15BTT401 Concepts of Industrial Biotechnology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S					S							S	
CO2			S							M			S	
CO3				W		S							S	
CO4	S	M			S								S	
CO5			S										S	
CO6										M		M	S	

COURSE ASSESSMENT METHODS:			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumnisurvey

Course content

RELATIONSHIP BETWEEN FOOD AND HEALTH **10 Hours**

Five food groups; Nutrition: Balanced diet, Essential amino acids and fatty acids, PER, Water soluble and fat soluble vitamins, Role of minerals in nutrition, Antinutrients, Nutrition deficiency diseases: Diabetes mellitus, marasmus, Kwashiokar, scurvy, Beri-beri, Rickets, Case study:Prevention and treatment of Diabetes Mellitus.

10 Hours

FUNCTIONAL FOODS AND NUTRACEUTICALS

Functional foods: categories of functional foods, processed foods, GM foods,role of biotechnology in functional foods, Nutrition related diseases and relevant functional foods : Atherosclerosis, cardiovascular disease, cancer, obesity, osteoporosis, Nutraceuticals: major nutraceuticals and their applications, Case study: Prevention of cancer using phytochemicals.

8 Hours

PROBIOTICS AND PREBIOTICS

Probiotics – definition, potential benefits, strains, advantages and disadvantage, genomics of probiotic lactic acid bacteria : impact on functional foods ; prebiotics: definition, types of new prebiotics and

9 Hours

BIOTECHNOLOGICAL APPROACHES TO MODIFY FOOD

Modern biotechnology for the production of dairy products; Modification of poultry and egg : genetic modification of the birds for meat and egg types birds, Bacterial food additives and dietary supplements; biotechnological modification of *Saccharomyces cerevisiae.* Biotechnological approaches to improve nutritional quality and shelf life of fruits and vegetables.

8 Hours

TECHNOLOGY FOR IMPROVED PROCESS

Technology for improved process Enzyme in bakery and cereal products, Enzymes in fat/oil industries, Protease in cheese making and beverage production.

Theory: 43 Hours **Tutorial /Practical/Case study:-2** **Total Hours :45**

REFERENCES:

1 Manay, N. Shakuntala. *Food: facts and principles.* New Age International, 2001.
2 Srilakshmi, B. *Food science*. New Age International, 2003.
3 Adams, M. R., and M. O. Moss. "*The microbiology of food preservation*." (2007)
4 Jean-Richard Neeser, and J. Bruce German, eds. *Bioprocesses and biotechnology for functional foods and nutraceuticals*. CRC Press, 2004.

OTHER REFERENCES:

1 Potter, Norman N., and Joseph H. Hotchkiss. *Food science.* Springer Science & Business Media, 2012.
2 Frazier, William Carroll. *Food microbiology. Micribiologia de los alimentos*. No. QR115. F718 1993.
3 Desrosier, Norman W., and James N. Desrosier. *The technology of food preservation*. No. Ed. 4. AVI Publishing Company, Inc., 1977.
4 www.fao.org/biotech/biotechnology-home/en

U15BTE202	BIOFERTILIZER AND BIOPESTICIDE DEVELOPMENT AND CONTROL	L	T	P	C
		3	0	0	3

Objective(s):

- To learn the production process in biofertilizer
- To learn the various process in biopesticide production.
- To learn various environmental application of biofertilizer and biopesticides

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 **:** Understand nitrogen fixing bacteria and soil fertility.
CO2 **:** Learn various production process and formulation of biofertilizer
CO3 **:** Learn various agricultural applications of biopesticides.
CO4 **:** Learn biocontrol agents and their applications.
CO5 **:** Understand various environmental applications.
CO6 **:** Apply knowledge of biocontrol and biopesticide agents in agriculture

Pre-requisite:

1 U15BTT302 Microbiology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S	S												
CO2		S												
CO3	S	S	S											
CO4							S							
CO5			M			S	S						M	
CO6		S												S

Course Assessment methods:

	Direct		Indirect
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Industry Survey
3	End semester examination	**3**	Alumni survey

Course Content

SOIL AND AGRICULTURAL MICROBIOLOGY **9 Hours**

Soil Habitat; Nitrogen fixation (symbiotic and nonsymbiotic), Microbial interaction; Isolation and

screening of industrially important microbes; Large scale cultivation of industrial microbes.Brief account of beneficial microorganisms – *RhizobiumAzotobacter* and *Azospirillum*; Phosphate solubilizing microorganisms; Vesicular Arbuscular Mycorrhizae (VAM); *Azolla*; Blue Green Algae (BGA); Plant growth promoting rhizobacteria (PGPR); Green manure

BIOFERTILIZER PRODUCTION PROCESS AND FORMULATION 9 Hours

Strain selection and improvement; culturing methods; mass production- sterilization; selection of raw material and dose determination, storage and maintenance. Formulation- EC, WP, Granules etc., Quality checking and approval; advantages over inorganic fertilizers.

BIOPESTICIDE PRODUCTION PROCESS AND FORMULATION 9 Hours

Market potential- need and demand; Impact on biopesticides; Formulation; Microbial preparation for agricultural applications- Insecticide, herbicide, Nematicide. Impact on flora and fauna. Pesticide usage trend and its harmful effects, Integrated Pest and Disease Management System (IPDMS); Biological control - conservation of natural enemies, release of parasites, use of microbial agents; Need-based application of pesticides, use of selective pesticide.

BIOCONTROL AGENTS 9 Hours

Biological control of insects - Fungal insecticides, bacterial insecticides - *Bacillus thuringlensls* (BT); Development of resistance; Improvements in BT through genetic engineering; Limitations of BT; Viral insecticides - Nuclear Polyhedrosis Virus; Protozon insecticides; Botanical pesticides; Pheramon trap; Trichocards; Nematodes as biological control agents; Biological control of weeds; Biological control of plant diseases - Soilborne diseases, foliar Diseases

ENVIRONMENTAL APPLICATIONS OF MICROBIAL FERTILIZER 9 Hours

Different methods for biofertilizer aaplication – granular and liquid; Different methods of inoculation - seed inoculation, top dressing of biofertilizers, broadcasting of granular biofertilizers, granular biofertilizer mixed with seed; Methods of application of liquid inoculation; Methods of application of other biofertilizers; Formulations for biocontrol agents; Factors affecting crop response to biofertilizers; Potential of biofertilizers and biocontrol agents in Indian agriculture.

Theory: 45 H Tutorial /Practical/Case study: Nil Total Hours Covered:45

REFERENCES:

1 NIIR Board: The Complete Technology Book on Biofertilizer and Organic FarmingNational Institute of Industrial Research, New Delhi. (2004)

2 Ghosh G. K: Bio-pesticide and Integrated Pest Management. APH Publishing Corp., New Delhi. (2000)

3 Van Emden HF and Service MW: Pest and Vector Control. CambridgeUniversityPress, UK. (2004)

OTHER REFERENCES

1 http://saspublisher.com/wp-content/uploads/2013/07/SAJP24327-332.pdf

2 http://www.fnca.mext.go.jp/english/bf/bfm/pdf/5_Quality_Control0403.pdf

U15BTE203	BIOTECHNOLOGY OF VALUE ADDED FOODS	L	T	P	C
		3	0	0	3

Objectives:

- To understand the relationship between nutraceuticals and value addition in foods
- To understand various methods of value addition of foods.
- To learn the biological processes for value addition in foods.

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 **:** Use the basic and applied knowledge gained through other courses in biotechnology to relate to nutraceuticals and value addition of foods.

CO2 **:** Understand various methods of value addition of foods.

CO3 **:** Perceive the expected benefits of value addition.

CO4 **:** Learn to use genetic engineering to modify and manipulate biological processes for value addition of foods.

CO5 **:** Understand the impact of value addition of foods.

CO6 **:** Understand the importance of economy and trade due to value addition.

Pre-requisite:

1 U15BTT301 Concepts in Biochemistry

2 U15BTT403 Food process engineering

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S	M		W	W	S							S	
CO2	S	M		M	M	M							S	
CO3	S	S	M	M	M	M							S	
CO4	S	M		S	S	M							S	
CO5	S	M	S	M	M	M							S	
CO6		M		S		M							S	

Course Assessment methods:			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course Content

INTRODUCTION TO NUTRACEUTICALS **9 Hours**

The history and scope of nutraceutical research; Microbial: fermented foods, bakery products, dairy products and mushrooms; Plant foods: cereals, pulses, legumes, oilseeds, vegetables and fruit crops; Fish, poultry, dairy and animal foods.

THE IMPORTANCE OF VALUE ADDITION OF FOODS **9 Hours**

Major and minor food constituents: Carbohydrates, proteins, fats, vitamins and minerals, value addition, types of value additions. The benefits of value addition to the foods.

VALUE ADDITION BY GENETIC MODIFICATION **9 Hours**

Value added microbial foods, value added transgenic plants. Value added transgenic animals. Floriculture and flower industry, Modification of farm products for better transportation, storage, consumer preference.

VALUE ADDITION OF FOODS FOR SUITABLILITY TO INDUSTRIAL PROCESSING **9 Hours**

Improvement of raw materials by conventional methods, improvement of raw material by application of biotechnology methods; Value added crops, designer crops, improvements of raw material for food processing industry.

IMPACT OF VALUE ADDITION OF FOODS ON FARM, NATIONAL ECONOMY AND TRADE **9 Hours**

Importance of value added crops in the farms, improvement in farm value and economy, farmer and industrial partnership, impact of biotech-products on national economy and international trade.

Theory: 45 Hours **Tutorial /Practical/Case study:Nil** **Total Hours Covered:45**

REFERENCES:

1 Channarayappa, Molecular Biotechnology**:** Principles and Practices,University Press (India) Pvt. Ltd., Worldwide CRC Press,2006.

2 Singh BD, Biotechnology- Expanding Horizons, Kalyani Publishers, Rajindernagar, Ludhiana, 2003.

3 Palaniappan SP and Annadurai K. Organic farming, Scientific Publishers (India), Jodhpur,2007.

4 Probir Kanti Biswas , Agricultural Biotechnology, Dominant Publishers and Distributors, New Delhi,2005.

5 Rajashekaran K, Jacks TJ and Finley JW ,Crop Biotechnology, American Chemical Society, Washington, DC, 2002.

OTHER REFERENCES:

1 Lindsey K and Jones MGK, Plant biotechnology in Agriculture. PrenticeHall, USA,1990.

U15BTE204	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

Objectives:

- To learn about the fundamentals of carcinogenesis and role of oncogenes
- To understand the regulation of cell cycle in cancer and mechanism of cancer metastasis
- To know about the strategies for cancer diagnosis and therapy

Course Outcomes :

At the end of the course student will be able to:

CO1 **:** Understand the mechanism of proto-oncogene and oncogene and apoptosis
CO2 **:** Describe the mechanism of cell cycle regulation in cancer
CO3 **:** Attain the knowledge in the fundamentals of carcinogenesis and its role in cancer
CO4 **:** Illustrate the mechanism of cancer metastasis and
CO5 **:** Comprehend the basis of cancer diagnosis and therapy
CO6 Apply techniques in the field of cancer diagnosis

Pre-requisite:

1 U15BTT404 Cell and Molecular Biology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(Pos)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S		S			M							S	
CO2	S			M									S	
CO3	S					S							S	
CO4	S		M			S							S	
CO5	S		S			S							S	
CO6	S		S			S							S	

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry survey
		4	Alumni survey

Course Content

Hours

ONCOGENES AND PROTO ONCOGENES **9 Hours**

Mechanism of oncogene and proto oncogene – epidermal growth factor (EGF), platelet derived

growth factor (PDGF), transforming growth factor (TGF), src and myc; RAS cycle; Oncogenes – Identification and detection; Apoptosis – intrinsic and extrinsic pathways. Genetic rearrangements in progenitor cells

CELL CYCLE REGULATION **9 Hours**

Regulation of cell cycle - *S. pombe, S. cerevesiae* and mammalian system; Types of mutations that cause changes in signal molecules; Effects on receptor; Tumor suppressor genes -p53 and Rb proteins; Modulation of cell cycle in cancer; Mechanism of action of telomerase. Interaction of cancer cells with normal cells

MECHANISM OF CARCINOGENESIS **9 Hours**

Carcinogenesis – introduction and types; Chemical carcinogenesis – Direct acting and indirect acting carcinogens; Metabolism of carcinogens - CYP450 reductase mechanism; Mechanism of radiation carcinogenesis – ionizing and non ionizing radiation; Retroviruses - RSV life cycle and its role in cancer; Identification of carcinogens- Long and short term bioassays.

MECHANISM OF CANCER METASTASIS **9 Hours**

Metastasis – Introduction and cascade; Clinical significances and three step theory of invasion; Significance of proteases in basement membrane disruption; Properties of cancer cell; Oral, lung, uterus, breast & blood – etiology, diagnosis and treatment.

Case study – oral, breast and blood cancers

CANCER DIAGNOSIS AND THERAPY **9 Hours**

Action of cancers – biochemical assays; Tumor markers; Molecular tools for early diagnosis of cancer; Prediction of aggressiveness of cancer; Different forms of therapy – stem cell therapy, Chemotherapy, Radiation therapy and Immunotherapy; Role of antioxidants in preventing cancer

Total Hours : 45

Theory: 45 h **Tutorial/practical: Nil** **Total Hours : 45**

REFERENCES:

1 Ian F.Tannock, Richard P. Hill, Robert G. Bristow and Lea Harrington., *The Basic Sciences of Oncology*, 4th Edition, The McGraw-Hill Companies, Inc. New Jersey, 2005.

2 Weinberg.,R.A., *The Biology of Cancer,* 1st Edition, Taylor and Francis, Garland Science. United Kingdom., 2007.

3 Pelengaris A.,and M. Khan (Eds)., *The Molecular Biology of Cancer,* Wiley - Blackwell Publishing, USA. 2006.

4 Gareth Thomas.,*Medicinal Chemistry – An Introduction*, 1st Edition, John Wiley and Sons, USA, 2004.

5 Benjamin Lewin., *Genes VIII,* International Edition, Pearson Prentice Hall, New Delhi. 2004.

6. Anthony S. Fauci, Dennis L. Kasper, Stephen L. Hauser, Dan L. Longo, J. Larry Jameson, Braunwald, Fauci and Isselbacher., *Harrison's Principles of Internal Medicine*, 17th Edition, McGraw Hill Medical Publishing Division. NewYork. 2008.

OTHER REFERENCES:

1 http://www.cyclacel.com/research_science_cell-cycle.shtml
http://www.cancer.org/treatment/treatmentsandsideeffects/treatmenttypes/

2 http://www.cancer.gov/about-cancer/treatment/types

U15BTE205	STEM CELLS AND TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

Objectives:

- To learn about the biology of stem cells and their differentiation
- To understand the concept of tissue engineering
- To know about the application of tissue engineering in regenerative medicine

Course Outcomes :

At the end of the course student will be able to:

CO1 **:** Understand the basics concepts of stem cells and their differentiation
CO2 **:** Comprehend the concepts of tissue engineering, scaffolds materials and designing
CO3 **:** Illustrate the applications of tissue engineering in tissue repair and dysfunction
CO4 **:** Apply the knowledge of biomaterials and biocompatibility
CO5 **:** Learn principles of tissue engineering
CO6 **:** Understand principles related to wound healing

Pre-requisite:

1 U14BTT505 Immunology

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1			S			M								S
CO2					S	M								S
CO3		S	M			S								S
CO4														S
CO5	S													S
CO6						M								S

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry
		4	Alumni

Course Content **Hours**

STEM CELLS **9 Hours**

Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Examples- mesenchymal, liver and neuronal stem cells; cord blood banking; telomeres and self renewal; stem cell plasticity.

STEM CELL DIFFERENTIATION **9 Hours**

Culture media for human embryonic and adult stem cells; growth factors; inducible pluoripotent cells; characterization and Differentiation of human embryonic stem cells - hematopoietic, neural and germ cell differentiation; conceptual and dynamic models of stem cell proliferative behavior.

CONCEPTS IN TISSUE ENGINEERING **9 Hours**

Cells as therapeutic agents- examples; cell numbers and growth rates; Tissue organization – components and types; Tissue dynamics – dynamic states, homeostatsis and tissue repair. Tissue Morphogenesis.

BIOMATERIALS IN TISSUE ENGINEERING **9 Hours**

Microscale patterning of cells and their environment. Cell interactions with polymers, matrix effects, polymer scaffold fabrication, biodegradable polymers, Micro and nano fabricated scaffolds, three dimensional scaffolds.

REGENERATIVE MEDICINE **9 Hours**

Medical and surgical therapies for tissue dysfunction; Tissue engineered therapies –Artificial Blood, Tissue Engineering of Bone Marrow; wound healing process and angiogenesis.
Case study – mesodermal (articular cartilage), ectodermal (skin), endodermal (liver).

Total Hours : 45

Theory: 45 Hr **Tutorial/ Case study: Nil** **Total Hours : 45**

REFERENCES:

1 Thomas C.G. Bosch., *Stem cells – From Hydra to Man*. First Edition, New Delhi, Springer International.2008.

2 Bernhard Palsson and Sangeeta N Bhatia., *Tissue Engineering, 2nd Edition*, New Delhi, Prentice Hall., 2009.

3 Robert Lanza, Robert Langer, Joseph Vacanti., *Principles of Tissue Engineering*, Academic Press. 2007.

4 Yoshito Ikada. *Tissue Engineering: Fundamentals and applications*, Elsevier International Projects Ltd., 2006.

OTHER REFERENCES

1 http://ocw.mit.edu/courses/biology/7-344-the-fountain-of-life-from-dolly-to-customized-embryonic-stem-cells-fall-2007/download-course-materials/

2 https://embryology.med.unsw.edu.au/embryology/index.php/Talk:Lecture_-_Stem_Cells

U15BTE206	BIOMATERIALS	L	T	P	C
		3	0	0	3

Objectives:

- To learn the basic concepts of the structures of various biomaterials
- To understand the mechanical properties, degradation and processing of biomaterials
- To understand the fundamentals of surface engineering and cell-biomaterial interactions
- To know the applications of biomaterials
-

Course Outcomes :

At the end of the course student will be able to:

CO1 : Explain the structure and applications of various types of biomaterials
CO2 : Demonstrate the mechanical properties of different variables of the biomaterials
CO3 : Illustrate the various types of biomaterial degradation, and the methods to improve the mechanical properties of biomaterials
CO4 : Demonstrate the fundamental concepts of different surface engineering techniques
CO5 : Describe the effects and efficacy of protein-biomaterial interactions
CO6 : Apply the biomaterials in the healthcare sectors

Pre-requisite:

1 U15CHT101 Engineering Chemistry
2 U15PHT101 Engineering Physics
3 U15PHT206 Applied Physics
4 U15BTT302 Microbiology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S	M		M	W							M	M	
CO2	S	M	S	S	S							M	S	
CO3	S	S	M	M	S	M						M	S	
CO4	S	M	W	S	M	W						M	W	

CO5	S	M	W	M	M	S						M	W	
CO6													S	

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

INTRODUCTION AND STRUCTURE OF BIOMATERIALS **9 Hours**

Introduction and definition of biomaterial; Types and applications of biomaterials; Biological response to biomaterials; Crystal structure of metals; Crystal structure of ceramics; Carbon based materials; General structure of polymers; Synthesis of polymers.

MECHANICAL PROPERTIES OF BIOMATERIALS **9 Hours**

Tensile and shear properties: molecular causes of elastic and plastic deformation, stress-strain curves of elastic and plastic deformation; Bending properties; Time dependent properties: creep properties of polymers; Influence of porosity and the degradation of mechanical properties; Introduction to fatigue.

BIOMATERIAL DEGRADATION AND PROCESSING **9 Hours**

Fundamentals of corrosion: redox reactions; Pourbaix diagram; Introduction to crevice and pitting corrosion; Degradation of polymers: hydrolysis, oxidation; Introduction to biodegradable polymers; Process to improve the mechanical strength of biomaterials: metals, ceramics and polymers; Processing of polymers to form desired shapes; Processing to improve biocompatabilty.

SURFACE ENGINEERING AND CELL & PROTEIN INTERACTIONS WITH BIOMATERIALS **9 Hours**

Surface modification of biomaterials: plasma treatment, radiation grafting, self assembled monolayers (SAMs), Langmuir – Blogett films, covalent biological coatings; Protein properties that affect biomaterial surface interaction; biomaterial surface interaction that affect interactions with proteins; Protein adsorption kinetics; DLVO model for cell adhesion; Assays to determine

the effects of cell-material interactions: agar diffusion assay, adhesion assays, migration assays.

APPLICATIONS OF BIOMATERIALS **9 Hours**

In vitro assays for inflammatory response due to biomaterial implantation; Fibrous encapsulation of healing process; Ideal features of soft tissue implants; Applications of sutures; Dental implants; Eye and ear implants; Heart valves; Endovascular stents.

Total Hours : 45

Theory: 45 Hours **Total Hours : 45**

REFERENCES:

1 Temenoff, Johnna S., and Antonios G. Mikos. *Biomaterials: the intersection of biology and materials science*. Illustrated Edition, ISBN: 978-81-317-2742-3, (First impression, 2009), 2014.

2 Park, Joon, and Roderic S. Lakes. *Biomaterials: an introduction*. Springer Science & Business Media, 3rd Edition, 2007.

3 Ratner, Buddy D., et al. *Biomaterials science: an introduction to materials in medicine*. 3rd Edition, Academic press, 2004.

OTHER REFERENCES

1 http://nptel.ac.in/courses/113104009/

2 http://www.bioen.utah.edu/faculty/pat/Courses/biomaterials/coursenotes.html

U15BTE207	CLINICAL RESEARCH &DATA MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVE(S):

- To be the biggest knowledge enhancement movement in the world in the area of Clinical Trial, Research & Administration

COURSE OUTCOMES :

At the end of the course student will be able to:

CO1 **:** Share knowledge in the emerging areas of Clinical Trial, Research & Administration

CO2 **:** Develop documentation / research writing expertise in the Clinical Trial, Research & Administration area.

CO3 **:** Equip participants of the BII Industry Program in Clinical Trial, Research & Administration to be able to spread awareness in this area by sharing their knowledge with others.

CO4 **:** Platform for interchange and exchange of knowledge in this area by organizing interaction Clinical Trial, Research & Administration Companies and program members.

CO5 **:** Understand the general principles on ethical considerations involving human

	subjects
CO6	Understand the produce to do different phases of clinical trial and approval process

Pre-Requisite:

1	U15BTT603 Biopharmaceutical Technology and regulatory practices
2	U15BTT505 Immunology and Microbial pathogenesis

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSPO1**	**PSPO2**
CO1	W												S	
CO2	M	W		W									S	
CO3	M	W	W										S	
CO4		S											S	
CO5	W												S	
CO6		S											S	

Course Assessment methods:

Direct		**Indirect**	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

Hours

CLINICAL TRIALS **9 Hours**

Clinical Trials & Clinical Research; Clinical Trials : Terminology, Features of Clinical Trials; Good Clinical Trial Practices; Patient Recruitment, Statistics Bioavailability, Studies Research Methodology Design of Experiments, Informatics, Trial Team, Delivery Model; Business Environment, Regulatory Affairs, Bioethics; Audit of Clinical Trials/Case Studies.

9 Hours

CONTRACT RESEARCH

Contract Research Organization; Academic Research Organization Contract Research Areas; Contract Research: Delivery Model, Business Environment, Information Sources IT; Regulatory Affairs and Contract Research Case Studies.

9 Hours

CONTRACT RESEARCH AND CLINICAL TRIAL ENVIRONMENT

Contract research need of organizations description; features and benefits of contract research; Contract research organizations in India; complementary and alternative medicine; Contract research and clinical trial environment in India; Non clinical safety studies for the conduct of human clinical

trials for pharmaceuticals; Choice of control group and related issues in clinical trials purposes of clinical trials and related issues Detailed consideration of types of control external control; Research Database Demonstrations "Clinical Data Management" for Pharma Trials.

9 Hours

GUIDELINES ON BIOMEDICAL RESEARCH ON HUMAN SUBJECTS

Statement of general principles on ethical Considerations involving human subjects. Ethical review procedures. General ethical issues. Statement of specific principles for clinical. Evaluation of drugs/devices/diagnostics/ Vaccines/herbal remedies. Statement of specific principles for: Epidemiological studies, human Genetics research, research In transplantation, including fetal tissue Transplantation, assisted Reproductive technologies.

9 Hours

SCHEDULE - Y

Approval for Clinical Trial; Responsibilities of: Sponsor, Investigator(s), Informed Consent, the Ethics Committee. Human Pharmacology: (Phase I); Therapeutic exploratory trials (Phase II); Therapeutic confirmatory trials (Phase III); Post Marketing Trials (Phase IV); Studies in Special Populations. Post Marketing Surveillance. Special Studies: Bioavailability / Bioequivalence Studies.

Theory:43 Hours	**Case Study: 02 Hours**	**Total Hours :45**

REFERENCES:

1 Bengt D. Furberg , Curt D. Furberg, (2007) "Evaluating Clinical Research: All That Glitters is Not Gold" 2nd edition , Springer publications

2 Stephen B Hulley, Steven R Cummings, Warren S Browner, Deborah G Grady, Thomas B Newman,(2008) Designing clinical research, Second edition Lippincott Williams & Wilkins Publishers

3 John I. Gallin and Fredrick P.Ognibene (2007). Principles and Practice of Clinical Research , Second Edition, Academic press

4 Antonella Bacchieri, Giovanni Della Cioppa (2007). Fundamentals of Clinical Research , First edition, Springer publishers

OTHER REFERENCES:

1 http://onlinelibrary.wiley.com/book/10.1002/9780470010167

2 http://clinicalcenter.nih.gov/training/training.html

3 http://www.picronline.org/contributors.asp

U15GST002	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

Objectives:

- Acquire knowledge on TQM concepts
- Acquire knowledge on quality systems
- Develop skills to use TQM tools for domain specific applications

Course Outcomes(COs)

At the end of the course student will be able to:

CO 1 : Understand quality concepts and philosophies of TQM
CO2 :Apply TQM principles and concepts of continuous improvement
CO 3:Apply and analyze the quality tools, management tools and statistical fundamentals to improve quality
CO 4 : Understand the TQM tools as a means to improve quality
CO 5 : Remember and understand the quality systems and procedures adopted
CO6:

Pre-requisite:

1. Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1									S					
CO2				M		M								
CO3	M	M			W						S			
CO4			M									M		
CO5											M			
CO6		S						M						

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry

		4	Alumni

INTRODUCTION **9 hours**

Definition of Quality, Dimensions of Quality, Quality costs, Top Management Commitment, Quality Council, Quality Statements, Barriers to TQM Implementation, Contributions of Deming, Juran and Crosby, Team Balancing

TQM PRINCIPLES **9 hours**

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Continuous Process Improvement,5S, Kaizen, Just-In-Time and TPS

STATISTICAL PROCESS CONTROL **9 hours**

The seven tools of quality, New seven Management tools, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Concept of six sigma.

TQM TOOLS **9 hours**

Quality Policy Deployment (QPD), Quality Function Deployment (QFD), Benchmarking, Taguchi Quality Loss Function, Total Productive Maintenance (TPM), FMEA

QUALITY SYSTEMS **9 hours**

Need for ISO 9000 and Other Quality Systems, ISO 9001:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 14001:2004

TOTAL: 45 HOURS

REFERENCE BOOKS:

1. Dale H.Besterfiled, “Total Quality Management”, Pearson Education
2. James R.Evans & William M.Lidsay, “The Management and Control of Quality”, South-Western (Thomson Learning), 2008.
3. Feigenbaum.A.V. “Total Quality Management”, McGraw Hill
4. Oakland.J.S. “Total Quality Management”, Butterworth – Hcinemann Ltd., Oxford
5. Narayana V. and Sreenivasan, N.S. “Quality Management – Concepts and Tasks”, New Age International 2007.
6. Zeiri. “Total Quality Management for Engineers”, Wood Head Publishers.

ELECTIVE- III

U15BTE301	NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Objectives:

- To develop the knowledge on nanomaterials synthesis characterization
- To gain knowledge in involvement of macromolecules in nanobiotechnology
- To study the application in drug delivery and cancer treatment

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 : Explain the basics of nanobiotechnology and synthesis of nanomaterials

CO2 : Apply the knowledge on characterization of nanoparticles with different techniques

CO3 : Explain the different nanomaterials applications

CO4 : Illustrate the interactions of nanomolecules in biosystem towards applications

CO5 : Describe the tissue regeneration and polymer nanofiber and its applications

CO6 : Discuss the applications of nanotechnology in biotechnology

Pre-requisite:

1 U15CHT101 Engineering Chemistry
2 U15PHT101 Engineering Physics
3 U15BTT201 Biomolecules and Genetics

CO/PO Mapping
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S	S				W								S
CO2	S	S	M											S
CO3	S		S											S
CO4	S		S	M										S
CO5	S	S												S
CO6		S			M									S

Course Assessment methods:

	Direct		Indirect
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey

3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

INTRODUCTION TO NANOBIOTECHNOLOGY **9 Hours**

Introduction to Nanotechnology and nanobiotechnology: Properties at nanoscale; overview of nanodevices and techniques; General synthesis methods of nanoscale materials; top down and bottom up approaches; Biological approach to self assembly.

NANOPARTICLES CHARACTERIZATION TECHNIQUES **9 Hours**

X-ray diffraction technique; Scanning Electron Microscopy with EDX; Transmission Electron Microscopy including high-resolution imaging; Surface Analysis techniques;: AFM, SPM, STM, SNOM, ESCA, SIMS; Nanoindentation.

9 Hours

NANOMATERIALS AND APPLICATIONS

Inorganic nanoscale systems for biosystems: nanostructure materials of fullerenes, carbon nanotubes, quantum dots and wires, preparation, properties and applications; Nanopores: applications.

NANOMOLECULES IN BIOSYSTEMS **9 Hours**

Nanomolecules in biosystems: Proteins, RNA and DNA nanoscale elements for delivery of materials into cells; DNA based artificial nanostructures; proteins as components in nanodevices; Tissue regeneration using anti-inflammatory nanofibres; Polymer nanofibers and applications; polymer nanocontainer; magnetosomes; bacteriorhodopsin: applications; S-layer proteins.

APPLICATION OF NANOBIOTECHNOLOGY **9 Hours**

Nanoscale devices for drug delivery: micelles for drug delivery; targeting; bioimaging; microarray and genome chips; nanobiosensors and nanobiochips; Nanotechnology for cancer diagnosis and treatment; Case study on drug delivery of gold nanoparticles against breast cancer.

Total Hours : 45

Theory: 45 Hr **Tutorial /Practical/Case study:1** **Total Hours Covered:45**

REFERENCES:

1 Niemeyer, C. M., and CA Mirkin, C. A., (2010); NanoBiotechnology II – More concepts, and applications. First edition, Wiley –VCH publications

2 Rosenthal, S.J. and Wright, D.W., (2010); Nanobiotechnology Protocols, First Edition, Humana Press
3 Jain, K. K. (2006); NanoBiotechnology in molecular diagnostics –current technique and applications, First edition, Taylor and Francis

OTHER REFERENCES:

1 Oded shoseyov & Ilan Levy (2008); Nanobiotechnology – Bioinspired and materials of the future. Humana press, New Jersey
2 http://www.understandingnano.com/nanoparticles.html

U15BTE302	BIOPROCESS ECONOMICS AND PLANT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVE(S)

- To make the students to analysis the concepts of bioprocess economics and plant design

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 Outline the concepts of design considerations
CO2 Analyze the plant design and unit operations
CO3 Design of bioreactors in bioprocess industries
CO4 Evaluate the Process Economics involved in bioreactor design
CO5 Explain the Bioprocess validation concepts
CO6 Outline different application of design in bioprocess industries

Pre-requisite courses:

1 U15BTT304 Stoichiometry and Fluid mechanics in bioprocess
2 U15BTT504 Heat and Mass Transfer in Bioprocess

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

	Programme Outcomes(POs)													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSPO1**	**PSPO2**
CO1	S													M
CO2	W	S	S						M			S		M
CO3	M	M	M						S			M		S
CO4		S							M					M
CO5					M		M							M
CO6	S											M		S

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Alumni survey

INTRODUCTION6 Hours

Review of mass and energy balance concepts. General overall design considerations, Development of the flow sheet and its description. Computer aided design, cost estimation, Engineering ethics in design.

10 Hours

PLANT DESIGN CONSIDERATION

Plant location, factors involved, selection of plant site, preparation of plant layout, plant operation and control, Piping and instrumentation diagrams. Selection and design of fluid moving machinery.Double pipe heat exchanger, shell and tube heat exchanger, evaporators, distillation columns, absorbers, driers, storage tanks, reaction vessels.

15 Hours

DESIGN OF BIOREACTORS

Materials of construction for bioprocess plant, Vessels for biotechnology application; Mechanical design of process equipment; Design considerations for maintaining sterility of process streams and process equipment; Selection and specification of major equipment used in bioprocess industries Design of cylindrical and spherical vessels for internal and external pressures, heads and closures, nozzles, supports, non-standard flanges, pipeline design. Design of tall vertical vessels. Design aspects aimed at maintaining aseptic conditions.

8 Hours

BIOPROCESS PROCESS ECONOMICS

Estimation of capital investment, estimation of operating cost, uncertainity analysis, profitability analysis of investments, bioprocess economics, Safety considerations

6 Hours

CASE STUDIES

Bioprocess validation. Case studies for Acetone-Butanol, Lactic acid, Industrial important Enzyme, Penicillin G, Vitamin C, Single cell protein, Biodiesel and Poly Hydroxy Butyrate

Total Hours :45

REFERENCES:

1 Pauline M. Doran, P.M. *Bioprocess Engineering Principles***,** 1st edition, Academic Press, First Print in India, New Delhi.1995

2 Bailey, J.E and Ollis, D.F. *Biochemical Engineering Fundamentals*. 2nd ed., McGraw-Hill International Editions, New York. 1990

3 Schuler, M.L., F.Kargi, F. *Bioprocess Engineering Basic Concepts*. 2nd ed. Printice Hall of India, New Delhi. 2004

OTHER REFERENCES:

1 Atkinson, B. *Bioprocess Technology-kinetics & Reactors*, 2nd Edition, Springer-Verlag, London. 1998

U15BTE303	INDUSTRIAL BIOSAFETY AND BIOETHICS	L	T	P	C
		3	0	0	3

Objectives:

- To provide knowledge on various aspects of Industrial biosafety
- To learn procedures and guidelines for biosafety
- To learn concepts of bioethics

Course Outcomes :

At the end of the course student will be able to:

CO1 : Describe various risks and different accidents that may occur at industrial level.
CO2 : Demonstrate about of level of biosafety.
CO3 : Elucidate various biosafety guidelines, norms and regulations.
CO4 : Assess GMO's and its regulation in terms of environmental release
CO5 : Acquire knowledge on ethical issues, guideline and regulations.
CO6 Describe environmental release of GMOs and their impact

Pre-requisite:

1. U15BTT302 Microbiology
2. U15BTT501 Genetic engineering
3. U15BTT603 Biopharmaceutical technology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S													
CO2	S	S	W		M									
CO3		M			S	W								
CO4		M	W		S									S
CO5		S			M	W						M		
CO6	S	S								S				S

Course Content

INDUSTRIAL BIOSAFETY **9 Hours**

Introduction to Biosafety; Causes: classification, identification of hazards; issues handling; awareness of accidents at industrial level; types of accidents; first aid, precautionary measure; Clean room procedures: Classification specification; Personal protective equipments working with biohazards; Proper gowering and hygiene for clean room work; Behavioral requirements in a controlled environment; Basic methods

for safe handling, transport, and storage of biological and chemical materials; Equipment related hazards; safe laboratory techniques; Contingency plan and emergency procedures

LEVELS OF BIOSAFETY **9 Hours**

Introduction to Biological safety cabinets; Horizontal &Vertical Laminar Air Flow Cabine; Fume hood; Primary and secondary containments; Biosafety levels of specific Microorganisms (food and water borne pathogens), Infectious Agents (Chemicals and carcinogens); MSDS (Material Safety Data Sheet); Understanding, and safe handling of test animals

FDA AND FPO BIOSAFETY GUIDELINES **9 Hours**

FDA guideline and approval; FPO specification and guidelines for food products; GOI: Biosafety procedure, time frames and specification for Production and manufacturing industries; **Case study**

INTRODUCTION TO BIOETHICS **9 Hours**

Definition of bioethics; Environmental release of GMOs: Risk analysis, Risk assessment, Risk management and Communication; Precaution before and after environmental release of GMO's; **case study**

REGULATORY AFFAIRS **9 Hours**

Overview of national regulation and international agreement on GMO; Cartagena protocol: articles; Ethical committee: administration channel; Role of NIH, IACUC,IBSC

Theory: 43 Hours **Case study: 2 Hour** **Total Hours: 45**

REFERENCES:

1 Deepa Goel and Shomini Parashar, *IPR, Biosafety and Bioethics*, Pearson Educationpublisher, (2013), ISBN 9789332514010

2 Erbisch, F.H, Maredia, K.M, *Intellectual property rights in agricultural biotechnology*, Universities Press (India) Ltd, 2000., ISBN 9788173712555

3 Singh. K.K, *Intellectual Property Rights in Biotechnology*, Springer India, 2015. ISBN 9788132220589.

4 Rajiv Jain, Rakhee Biswas. *Law Of Patents, Procedure and Practice*, Vidhi Publication, 1999, ISBN 9788187310327.

5 Sateesh, M. K. *Bioethics and biosafety*. IK International Pvt Ltd, 2010, ISBN 9788190675703

OTHER REFERENCES:

1 http://blink.ucsd.edu/safety/research-lab/biosafety/

2 http://www.fic.nih.gov/RESEARCHTOPICS/BIOETHICS/Pages/teachers-students.aspx

U15BTE304	ENVIRONMENTAL TOXICOLOGY AND OCCUPATIONAL HEALTH	L	T	P	C
		3	0	0	3

Objectives:

- To learn the principles of toxicology and to evaluate the effects of occupational hazard on health.

Course Outcomes :

At the end of the course student will be able to:

CO1 Learn the biochemical aspects of pollutants in environment.
CO2 Understand about biotransformation and detoxification.
CO3 To apply indices of toxicity in occupational health.
CO4 To assess epidemiological aspect of toxins.
CO5 Evaluate various testing procedures.
CO6 Understand role of carcinogens and toxic chemicals on health and environment

Pre-requisite:

1 U15GST001 Environmental Sciences and Engineering

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1				M			M							M
CO2				M										S
CO3			S				M							S
CO4							M							M
CO5			M	M	M		M							S
CO6			S					M						S

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry
		4	Alumni

Course Content **Hours**

TOXICANTS OF ENVIRONMENT **9Hour**

Toxic chemicals in the environment, Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon Monoxide, Ozone and particulates.

MECHANISMS OF TOXICITY **9Hour**

Mode of entry of toxic substance, biotransformation of xenobiotics, detoxification. Chemical carcinogens, mechanism of carcinogenicity.

INDICES OF TOXICITY **9Hour**

Indices of toxicity – threshold dose, LD50 and LC50, MIC & IC50 Dose – response relationship. Forensic toxicology. Factors affecting toxicity of a chemical agent.

FACTORS OF ENVIRONMENTAL HEALTH **9Hour**

Biogeochemical factors in occupational health. Epidemiological issues-goiter, fluorosis, arsenic poisoning.

SUSTAINABLE DEVELOPMENT OF ECOSYSTEM **9Hour**

Tissue toxicity, interference in enzyme activity, interference in nucleic acids and protein biosysnthesis. Detection – Testing chemicals for their carcinogenic, mutagenic and teratogenic actions. Case Studies.

Total Hours: 45

Lecture: 45 **Total Hours : 45**

Text book:

1 R.B. Philip, Environmental hazards & human health, CRC press, Florida, USA, 2013.

2 Levy B, Wegman D.H., Baron S.L., Sokas R.K., Occupational and Environmental Health: Recognizing and Preventing Disease and Injury, Oxford University Press, USA, 2011.

3 Maxwell N.C., Understanding Environmental Health: How We Live in the World, Jones & Bartlett Learning, USA, 2014.

4 Niesink and Devries J, 1996, Toxicology - principles & applications, CRC Press, USA, 1996.

Web references:

1 http://www.atsdr.cdc.gov/training/toxmanual/modules/1/lecturenotes.html

2 http://www.webpages.uidaho.edu/etox/lectures.htm

3 http://ocw.mit.edu/courses/biological-engineering/20-104j-chemicals-in-the-environment-toxicology-and-public-health-be-104j-spring-2005/lecture-notes/

4 http://ocw.jhsph.edu/courses/publichealthtoxicology/lectureNotes.cfm

U15BTE305	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Objectives:

To equip the students in understanding various aspects of the environment and how Biotechnology could be applied in finding sustainable solutions to environmental issues.

Course Outcomes :

At the end of the course student will be able to:

CO1 **:** Identify the key concepts in ecosystems management
CO2 **:** Summarize wastewater characteristics and treatment protocols
CO3 **:** Construct systems for biotreatment of industrial effluents and solid wastes
CO4 **:** Review the biodegradation pathways for xenobiotic compounds
CO5 **:** Apply the concepts in developing environment-friendly bioproducts
CO6 **:** Understand concepts of biodiversity and IPR related issues

Pre-requisite:

1 U15GST001 Environmental Sciences and Engineering
2 U15BTT302 Microbiology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S					W	M							S
CO2	S				M		S							S
CO3	S		M		W		S							M
CO4	S	M	S				S							S
CO5		S					M							S
CO6		S					M							S

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry
		4	Alumni

Hours

Course Content

ECOSYSTEMS AND THEIR MANAGEMENT **9 Hours**

Microbial communities of air, water and soil ecosystems; ecological adaptations and interactions between microorganisms; biogeochemical role of microorganisms; soil, air and water pollution – types, causes and effects; contributions of biotechnology to environmental management; environmental monitoring and risk assessment

Case study: environmental impact assessment (EIA)

WASTEWATER TREATMENT **9 Hours**

Physical, chemical and biological characteristics of wastewater; wastewater treatment – overview of physical and chemical methods; biological methods - suspended growth and biofilm processes; design of activated sludge process; ponds and lagoons; trickling filters; anaerobic reactors for wastewater treatment; sludge digestion - design of anaerobic sludge digesters; tertiary treatment - nitrogen and phosphorus removal

INDUSTRIAL AND SOLID WASTE MANAGEMENT **9 Hours**

Leather, pulp, pharmaceutical, dairy and textile industries – production process, origin and characteristics of waste, waste minimization and treatment options; solid waste management – segregation, collection, transportation, characterization, disposal methods – sanitary landfill, incineration, composting and vermicomposting, recovery of energy from solid waste; hazardous waste management – biomedical waste

case study: solid waste management in Indian cities

BIODEGRADATION AND BIOREMEDIATION **9 Hours**

Xenobiotics - factors causing molecular recalcitrance; microbial pathways for biodegradation of petroleum hydrocarbons – aliphatic, alicyclic, single-ringed and polycyclic aromatics, chlorinated hydrocarbons; biodegradation of pesticides and synthetic detergents, bioremediation – types and applications, use of genetically engineered microorganisms in bioremediation; role of biosurfactants in bioremediation

APPLICATIONS OF ENVIRONMENTAL BIOTECHNOLOGY **9 Hours**

Biocatalysts for environmental applications; biocontrol agents – biofertilizers and biopesticides; biopolymers; bioleaching; biofuels; biodiversity – values and threats faced, biodiversity conservation and role of biotechnology in it; intellectual property rights and patenting

Total Hours : 45

Theory: 45Hrs **Total Hours : 45**

REFERENCES:

1 Rittman B. and Mac Carty L., Environmental Biotechnology: Principles and Applications, New York: McGraw Hill Publishing Company, 2007.

2 Peavy S., Rowe R. and Tchobanoglous, Environmental Engineering, New York: McGraw

Hill Publishing Company, 2010.
3 Patwardhan AD., Industrial Wastewater Treatment. New Delhi: PHI Learning Pvt. Ltd., 2008.
4 Atlas R.M. and Bartha R., Microbial Ecology: Fundamentals and Applications, 6th edition, Benjamin / Cummings Publishing Company, 2008.
5 Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, 5th edition, New Delhi: Tata McGraw Hill Publishing Company, 2007.

OTHER REFERENCES:

1 http://www.mhhe.com/engcs/civil/rittmann/
2 http://unaab.edu.ng/colleges/environmental-resources-management/environmental-management-and-toxicology/lectures-notes.html
3 http://home.engineering.iastate.edu/~tge/ce421-521/lecture.htm

U15GST003	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

Objectives:

- To study the importance and functions of management in an organization
- To study the importance of planning and also the different types of plan
- To understand the different types of organization structure in management
- To understand the basis and importance of directing and controlling in management
- To understand to the importance of corporate governance and social responsibilities.

Course Outcomes(COs)

At the end of the course student will be able to:

CO1: Understand the concepts of management, administration and the evolution of management thoughts.
CO2: Understand and apply the planning concepts
CO3: Analyze the different organizational structures and understand the staffing process.
CO4: Analyze the various motivational and leadership theories and understand the communication and controlling processes.
CO5: Understand the various international approaches to management

Pre-requisite:

1. Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1					W					M	S			
CO2											S			
CO3			S											
CO4									S					
CO5											M			

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry
		4	Alumni

MANAGEMENT CONTEXT **9 hrs**

Management – Definition – Importance – Functions – Skills required for managers - Roles and functions of managers – Science and Art of Management –Management and Administration.
Evolution of Classical, Behavioral and Contemporary management thoughts.

PLANNING **9 hrs**

Nature & Purpose – Steps involved in Planning – Forms of Planning – Types of plans – Plans at Individual, Department and Organization level - Managing by Objectives. Forecasting – Purpose – Steps and techniques. Decision-making – Steps in decision making.

ORGANISING **9 hrs**

Nature and Purpose of Organizing - Types of Business Organization - Formal and informal organization – Organization Chart – Structure and Process – Strategies of Departmentation– Line and Staff authority – Benefits and Limitations. Centralization Vs De-Centralization and Delegation of Authority. Staffing – Manpower Planning – Recruitment – Selection – Placement – Induction.

DIRECTING & CONTROLLING **9 hrs**

Nature & Purpose – Manager Vs. Leader - Motivation - Theories and Techniques of Motivation.
Leadership – Styles and theories of Leadership.
Communication – Process – Types – Barriers – Improving effectiveness in Communication.

Controlling – Nature – Significance – Tools and Techniques.

CONTEMPORARY ISSUES IN MANAGEMENT **9 hrs**

Corporate Governance Social responsibilities – Ethics in business – Recent issues.

American approach to Management, Japanese approach to Management, Chinese approach to Management and Indian approach to Management.

TOTAL HOURS: 45

REFERENCES:

1. Tripathy PC And Reddy PN, "Principles of Management", Tata McGraw-Hill, 4th Edition, 2008.
2. Dinkar Pagare, "Principles of Management", Sultan Chand & Sons, 2000.
3. Kanagasapapathi. P (2008) Indian Models of Economy, Business and Management, Prentice Hall of India, New Delhi, ISBN: 978-81-203-3423-6.
4. G.K.Vijayaraghavan and M.Sivakumar, "Principles of Management", Lakshmi Publications, 5th Edition, 2009.
5. Harold Koontz & Heinz Weihrich, "Essentials of Management – An International perspective", 8th edition. Tata McGraw-Hill, 2009.
6. Charles W.L. Hill and Steven L McShane – Principles of Management, Tata Mc Graw-Hill, 2009.

ELECTIVE IV

U15BTE401	PROTEIN STRUCTURES AND ENGINEERING	L	T	P	C
		3	0	0	3

Objective(s):

- To learn the various topologies of supersecondary, tertiary and quaternary structures
- To understand the relationship between protein structure and function using some models
- To learn the fundamentals of protein engineering and design

Course Outcomes :

At the end of the course student will be able to:

CO1 : Explain and analyze the primary, secondary, and various supersecondary structural proteins

CO2 : Discuss the structural characteristic features of different types of tertiary structural domains

CO3 : Describe the structural characteristic features of various types of quaternary structural domains

CO4 : Demonstrate the significance of protein – non-protein interactions, and membrane proteins

CO5 : Explain the fundamentals and applications of protein engineering

CO6 : Describe the protein engineering design to construct various proteins

Pre-requisite:

1 U15BTT201 Biomolecules and Genetics

2 U15BTT301 Concepts in Biochemistry

3 U15BTT404 Cell and Molecular Biology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S		M	M	M							S	S	
CO2	S	M	M	S	W							S	S	
CO3	S	S	M	S								S	S	
CO4	S	M		M	W							M	M	
CO5	M	S	W	S	W							M	M	
CO6	M			S								S	S	

Course Assessment methods:			
Direct		**Indirect**	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

SECONDARY AND SUPER SECONDARY STRUCTURES **9 Hours**

Primary structure: Insulin; Secondary structures: Alpha (keratin), beta (silk fibroin), loop structures, structure of collagen; Super secondary structures: Helix-turn-helix, hairpin β motif, Greek key motif, Beta-alpha-beta motif, topology diagrams; Ramachandran plot.

TERTIARY AND QUATERNARY STRUCTURES **9 Hours**

Tertiary structure: types of different domains (α, β and α / β); α domain: Coiled to coil structure, Four helix bundle; β domain: up and down, Greek key, jelly roll barrels; α / β domains: TIM barrel, glycolate oxidase, methyl malonyl CoA mutase, Rossman fold, Horseshoe fold; Protein folding : role of molecular chaperones, protein disulphide isomerase, peptidyl prolyl cis-trans isomerase; Quaternary structure **:** Modular nature, formation of complexes.

PROTEIN STRUCTURE-FUNCTION RELATIONSHIP **9 Hours**

DNA-binding proteins: Prokaryotic transcription factors, helix-turn-helix motif of Trp- repressor & Cro protein in DNA binding; Eukaryotic transcriptionfactors ; TATA box-binding proteins, TFIIA and TFIIB; Homeodomain; Zn-fingers; Membrane Proteins: General characteristics, K-Channel, Bacteriorhodopsin, and Photosynthetic reaction center.

FUNDAMENTALS OF PROTEIN ENGINEERING **9 Hours**

Introduction; Strategies for protein engineering: rational and *de novo* design; strategies to improve the protein stability; Site directed mutagenesis: M13, plasmid DNA, PCR, nucleotide analogs, primer based and DNA shuffling; Solvent engineering: Lipase.

PROTEIN ENGINEERING DESIGN **9 Hours**

Protein engineering design: Thermal stability of T4-lysozyme, Recombinant insulin; *In silico* engineering of proteins; Abzymes; Enzymes :Understanding catalytic design by engineering subtilisin, alcohol

dehydrogenase, lactate dehydrogenase, β-glycoside hydrolases, chymotrypsin; Streptavidin & STREP-tag for affinity purification; Antibody engineering : introduction and production of recombinant bispecific antibodies.

Case study: Design and expression of heterologous protein (insulin) in *Pichia pastoris*

Theory: 45 Hr **Total Hours : 45**

REFERENCES:

1. Branden C and Tooze J. *Introduction to protein structure*. 2nd Edition, Garland Science, ISBN: 978-0-8153-2305-1,1999.
2. Voet D and Voet G. *Biochemistry,* 4th edition, John Wiley & Sons ISBN: ISBN-13: 978-0471586517, ISBN-10: 047158651X, 2010.
3. Fersht, Alan. *Structure and mechanism in protein science: A Guide to Enzyme Catalysis and Protein Folding.*3rd revised edition, W.H.Freeman & Co Ltd.ISBN-13: 978-0716732686, 1999.
4. Kaumaya, Pravin, ed. *Protein Engineering*. InTech, 2012. (Open Access Book)**.**
5. Moody, Peter CE, Anthony J. Wilkinson, and Tony Wilkinson. *Protein engineering*. 2nd Edition, Oxford University Press, USA, ISBN: 0199631948, 9780199631940 1990.
6. Thomas E. Creighton. *Proteins: structures and molecular properties*. 2nd Edition, Macmillan, ISBN: 071677030X, 9780716770305,1993.
7. Creighton, Thomas E. *Protein structure: a practical approach*. 2nd Edition, IRL press at Oxford University Press, ISBN: 0199636184, 9780199636181, 1997.
8. Alberghina, Lilia, ed. *Protein Engineering for Industrial Biotechnology*. CRC Press, ISBN: 90-5702-412-8, 2003.
9. Schulz, Georg E., and R. Heiner Schirmer. *Principles of protein structure*. 1st Edition re-print, Springer Science & Business Media, ISBN-13: 978-0-387-90334-7, e-ISBN-13: 978-1-4612-6137-7, 2013.

OTHER REFERENCES:

1 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2763986/

2 www.niscair.res.in/sciencecommunication/ResearchJournals/rejour/ijbt/ijbt2k6/ijbt_july06.asp

3 http://books.google.co.in/books?id=x0UyTLIhWSAC&pg=PA227&source=gbs_toc_r&cad=3#v=

onepage&q&f=false

4 http://books.google.co.in/books/about/Antibody_Engineering.html?id=x0UyTLIhWSAC

U15BTE402	STRUCTURAL BIOINFORMATICS AND COMPUTER AIDED DRUG DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge of structure elucidation and prediction
- To learn principles of molecular modeling and drug discovery

COURSE OUTCOMES :

At the end of the course student will be able to:

CO1 : Describe the various structural databases and their access

CO2 : Describe conformational analysis of proteins

CO3 : Enumerate the various structure prediction methods

CO4 : Identify the mechanisms of protein modeling and molecular dynamics

CO5 : Illustrate the principles of molecular docking

CO6 : Explain principles of drug design

PRE-REQUISITE:

1 U15BTT304, Bioorganic chemistry

2 U15BTT701, Bioinformatics

3 U15BTT703Biopharmaceutical technology and regulatory practices

CO/PO Mapping

S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S													
CO2	S													
CO3	S		M											
CO4	M													
CO5	W	S			M	S		M				M		
CO6	S				S			M						

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry
		4	Alumni

Course Content

STRUCTURAL DATABASES AND GENOMICS: 9 Hours

Diversity of Living Organisms: Cells and Cell theory; cell types and Structure; Cell division in prokaryotes and eukaryotes; Central dogma and information flow; Cell metabolism- Homoeostasis- Cell growth, reproduction, differentiation and stem cells.

CONFORMATIONAL ANALYSIS: 9 Hours

Proteins: Forces that determine protein structure, polypeptide chain geometries – Ramachandran Map – potential energy calculations, observed values for rotation angles – structure comparison and alignment; Nucleic acids and carbohydrates: general characteristics of nucleic acid structure – geometries, glycosidic bond – rotational isomers and ribose puckering - forces stabilizing ordered forms – base pairing –base stacking

DETERMINATION AND PREDICTION OF STRUCTURE 9 Hours

X- ray crystallography – X–ray diffraction, determination of molecular structures,
neutron scattering, NMR spectroscopy, Algorithms for prediction of structure of peptides, proteins and nucleic acids. prediction of secondary structure – Chou- Fasman, Garnier-Osguthorpe-Robson (GOR) methods – transmembrane structure prediction – solvent accessibility calculations and prediction. Homology modeling and abinitio modeling. Constructing and Evaluating a Comparative
Model. Comparison of Protein Structure Prediction Methods: CASP.

MOLECULAR MODELING AND DOCKING 9 Hours

Types of molecular modeling; Principles of Monte Carlo and Molecular Dynamics simulations; Introduction to molecular docking, Rigid docking, Flexible docking, manual docking, Advantage and disadvantage of Flex-X, Flex-S, AUTODOCK and other docking software, Scoring Functions, Simple Interaction Energies, GB/SA scoring (implicit solvation), CScore (consensus scoring algorithms).

DRUG DISCOVERY AND DESIGN: 9 Hours

General approach to discovery of new drugs - lead discovery – lead modification –
physiochemical principles of drug action – drug stereo chemistry –drug action
- 3D database search – computer aided drug design – docking - molecular modeling in drug design – structure based drug design – pharmacophores - QSAR.

Theory: 45 Hours Total Hours :45

REFERENCES:

1 Cantor, Charles R., and Paul R. Schimmel. *Biophysical chemistry: Part III: the behavior of biological macromolecules*. Macmillan, 1980.

2 Yeargers, Edward K. *Basic Biophysics for Biology*. CRC-Press, 1992.

3 Van Holde, Kensal Edward, W. Curtis Johnson, and Pui Shing Ho. "Principles of physical biochemistry." (2006).
4 Gu, Jenny, and Philip E. Bourne. *Structural bioinformatics*. Vol. 44. John Wiley & Sons, 2009.
5 Branden, Carl Ivar. *Introduction to protein structure*. Garland Science, 1999.

OTHER REFERENCES:
1 http://www.cs.cmu.edu/~ckingsf/bioinfo-lectures/

U15BTE403	ENVIRONMENTAL BIOTECHNOLOGY RISK AND IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To learn and practice environmental risk and impact assessment
- To assess and evaluate the risk/ impact involved in environmental biotechnology.

COURSE OUTCOMES:
At the end of the course student will be able to:

CO1 : Outline the concepts of environmental impact assessment
CO2 : Explain the legislations and implementation of risk assessment
CO3 : Design various audits and life cycle assessment
CO4 : Apply the concepts for hazard identification and risk characterization
CO5 : Evaluate the risks of genetically modified organisms
CO6 : Analyze the feasibility of sustainable development

Pre-requisite:
1 U15GST001 Environmental Sciences and Engineering
2 U15BTT404 Cell and Molecular Biology

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1							M							S
CO2							M					M		S
CO3			S		M		S		S					M
CO4					M	M	S					S		S
CO5			M	M	S	S	M							S
CO6				M	M				S					S

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

CONCEPTS OF RISK ASSESSMENT **9 Hours**

Introduction to environmental impact analysis; Environmental impact statement and environmental management plan; ISO14000; Mitigation: Matrices; Checklist.

ECOSYSTEM FUNCTIONS **9 Hours**

Impact assessment methodologies; Generalized approach to impact analysis; Rapid and comprehensive environmental impact assessment (EIA); Legislative and environmental clearance procedures in India; Prediction tools for EIA.

ECO-TECHNOLOGIES **9 Hours**

Documentation of EIA; Environmental management plan; Post project monitoring; Environmental audit; Guidelines for environmental audit; Baseline information and prediction; Life cycle assessment in environmental management systems; Restoration and rehabilitation technologies. **Case studies** in EIA.

ECOLOGICAL ENGINEERING APPLICATIONS **9 Hours**

Risk analysis: Definition of risk; Environmental risk analysis; Risk assessment and risk management; Basic steps in risk assessment; Hazard identification; Dose-response assessment; Exposure assessment; Risk characterization.

SUSTAINABLE DEVELOPMENT OF ECOSYSTEM **9 Hours**

Environmental biotechnology risk and impact assessment matrix; Ethical and legal issues in genetically modified microorganisms; risk groups; biosafety standards and measures; Expert committees (RDAC- Recombinant DNA Advisory Committee, GEAC- Genetic Engineering Approval Committee, SBCC- State Biotechnology Coordination Committee, DLC- District Level Committee); Environmental approval.

Theory:43 hours **Case study: 2 hours** **Total Hours : 45**

REFERENCES:

1 Glasson, John, RikiTherivel, and Andrew Chadwick. *Introduction to environmental impact assessment*. Routledge, 2013.

2 Therivel, Riki. *Strategic environmental assessment in action*. Routledge, 2012.

3 Carroll, Barbara, and Trevor Turpin. *Environmental impact assessment handbook: A practical guide for planners, developers and communities*. Thomas Telford, 2002.

4 Levin, Morris A., and Harlee S. Strauss. *Risk assessment in genetic engineering*. McGraw-

Hill, 1991.
5 Ripp, Steven, and Theodore B. Henry. *Biotechnology and Nanotechnology Risk Assessment: Minding and Managing the Potential Threats Around Us*. Vol. 1079. American Chemical Society, 2011.

OTHER REFERENCES:

1 http://www.gdrc.org/uem/eia/impactassess.html
2 http://www.ce.utexas.edu/prof/maidment/risk/risksyl.html

U15BTE404	BIOFUELS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE(S)

- To make the students to acquire knowledge on biofuels

COURSE OUTCOME(S):

At the end of the course student will be able to:

CO1: Outline the concepts of biomass and biorefinery
CO2: Discuss the feedstocks, catalysts and characterization of biodiesel
CO3: Explain the pretreatment, production process and estimation of bioethanol
CO4: Describe the technology and challenges of biohydrogen and bioemethane production
CO5: Outline the applications of fuel cells
CO6: Design and fabrication of microbial fuel cells

PRE-REQUISITE(S):

1. U15BTT301 Concepts in Biochemistry
2. U15BTT401 Industrial Biotechnology
3. U15BTT502 Enzyme Technology
4. U15BTT503 Bioprocess Engineering

CO/PO MAPPING
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	M													M
CO2	S	S	S						M			M		W
CO3	S	M	S						M			M		S
CO4		M							M					W
CO5					M		W							W
CO6					M		W							W

COURSE ASSESSMENT METHODS:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

COURSE CONTENT:

BIOMASS AND BIOREFINERY **9 Hours**

Biomass: Generation and utilization, types, properties, biomass for biorefinery; Biorefinery: Concept, Bioproducts from biorefinery; Physico-chemical biorefinery: Oil extraction and transesterification; Thermo-chemical biorefinery: Pyrolysis, Carbonization, liquefaction, gasification, Combustion; Bio-chemical biorefinery: Anaerobic digestion and fermentation, Food-fuel conflict.

BIODIESEL **9 Hours**

Biodiesel: Feedstocks and their characterization, production process; Catalysts for biodiesel production: Chemical, Biological, Biochemical and nanomaterials; Purification and characterization of biodiesel; International and national standards for biodiesel; Challenges and problems in biodiesel production.

BIOETHANOL **9 Hours**

Bioethanol: Feedstocks and their characterization, production process, Pretreatment of lignocellulosics; Microbes for bioethanol production: Amylolytic, Cellulolytic and ethanologenic; Purification and quantification of bioethanol; Challenges and problems in bioethanol production

BIOMETHANE AND BIOHYDROGEN **9 Hours**

Biomethane: Feedstocks and their characterization, production process; Microbiology of biomethane production; Biohydrogen: Production by biophotolysis and fermentation, detection and quantification; Challenges and problems in biomethane and biohydrogen production; Overview of hythane.

MICROBIAL FUEL CELLS **9 Hours**

Microbial fuel cells: Biochemical basis, design and fabrication, performance and its methods, applications, challenges and problems.

THEORY: 45 **TOTAL HOURS: 45**

REFERENCE(S):

1. Caye Drapcho, John Nghiem, Terry Walker*Biofuels Engineering Process Technology* McGraw-Hill, 2008
2. Khanal, Samir Kumar, et al. *Bioenergy and biofuel from biowastes and biomass*. American Society of Civil Engineers (ASCE), 2010.

3. Ashok. Pandey, ed. *Handbook of plant-based biofuels*. CRC Press, 2008.
4. Fang, Zhen. *Pretreatment techniques for biofuels and biorefineries*. Springer Berlin Heidelberg, 2013.

OTHER REFERENCE(S):

1. Gouveia, Luisa. *Microalgae as a feedstock for biofuels*. Springer Berlin Heidelberg, 2011

U15BTE405	GREEN TECHNOLOGIES IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the principles of toxicology.
- To evaluate the effects of occupational hazard on health.

COURSE OUTCOMES:

At the end of the course student will be able to:

CO1 Apply microbial concepts in making fuels.
CO2 Evaluate the role of plants as factories for bioproducts and bioenergy
CO3 Assess avenues for environmental cleanup.
CO4 Demonstrate harnessing alternative renewable green energy.
CO5 Describe various concepts in Nanotechnology for application in green synthesis.
CO6 Explain the role of Nanotechnology in developing environment-friendly biomaterials

Pre-requisite:

1 U15GST001 Environmental Sciences and Engineering
2 U15BTT302 Microbiology

CO/PO Mapping
***S-Strong, M-Medium, W-Weak**

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1				M			M							M
CO2				M			M					M		S
CO3			S				M	S						S
CO4							M	S						M
CO5			M	M	M		M							S
CO6			S		M							S		S

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

INTRODUCTION TO GREEN CHEMISTRY 9 Hours

Introduction to green chemistry**;** Principles of green chemistry; advantages of adopting green chemistry (concepts on minimization of resource utilization and waste generation);Green reactions: Solvent free reactions, Catalyzed (heterogeneous/homogeneous) reactions, MW/ ultrasound mediated reactions; Bio catalysts.

GREEN TECHNOLOGY FOR FUELS 9Hours

Hydrocarbon biosynthesis in microorganisms; Microbiology and hydrocarbon products; Enzymes and mechanisms of hydrocarbon biosynthesis; Tailoring plant cell wall composition and architecture for conversion to liquid hydrocarbon biofuels; Processive cellulose; Microbial strategies for biomass conversion; Fuels from fungi and yeast; Plants as factories for industrial products, pharmaceuticals, biomaterials and bioenergy.

CLEANUP, RECOVERY AND MAINTENANCE 9Hours

Green technology in resource minimization, waste minimization; Cleaner production; Green reactions: solvent free reactions; Bio-catalysts; Phytoremediation; Bioremediation; Biodegradation; Environmental sustainability.

Case studies in cleaner production

ENERGY SOURCES AND ALTERNATIVES 9Hours

Criteria for choosing appropriate green energy technologies; Renewable energy technologies; Bio Hythane; Green technologies for addressing the problems of agriculture; Green technologies for addressing the problems in Biodiversity; Ecosystem restoration.

GREEN NANOTECHNOLOGY 9Hours

Greener nano synthesis: Greener synthetic methods for metal nano particles; Green materials: Biomaterials, biopolymers, bioplastics, and composites; Nanomaterials for fuel cells and hydrogen; nanotechnology in hydrogen storage applications; Smart biomaterials.

Case studies in smart biomaterials

Theory Hours: 43 Case studies: 2 Total Hours : 45

REFERENCES:

1 Himmel, Michael E., ed. *Direct Microbial Conversion of Biomass to Advanced Biofuels*. Elsevier, 2015.
2 Arceivala, Soli J. *Green Technologies: For a Better Future*. McGraw-Hill Education, 2014.
3 Mulvaney, Dustin, ed. *Green technology: an A-to-Z guide*. Vol. 10. Sage, 2011.
4 Karkare, Manasi. *Nanotechnology: Fundamentals and Applications*. IK International Pvt Ltd, 2008.
5 Fulekar, M. H. *Nanotechnology: importance and applications*. IK International Pvt Ltd, 2010.

OTHER REFERENCES:

1 http://www.green-technology.org/green_tech.htm
2 http://ocw.mit.edu/courses/mechanical-engineering/2-57-nano-to-macro-transport-processes-spring-2012/video-lectures/

U15GST004	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

Objectives:

- Apply knowledge of OR techniques to domain specific industrial situations to optimize the quality of decisions
- Conduct investigations by the use of OR techniques

Course Outcomes(COs)

At the end of the course student will be able to:

CO1: Apply linear programming model and assignment model to domain specific situations
CO2: Analyze the various methods under transportation model and apply the model for testing the closeness of their results to optimal results
CO3: Apply the concepts of PERT and CPM for decision making and optimally managing projects
CO4: Analyze the various replacement and sequencing models and apply them for arriving at optimal decisions
CO5: Analyze the inventory and queuing theories and apply them in domain specific situations.

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S	S	S	M										
CO2	S	S	S	S										
CO3	S	S	M	M										
CO4	S	M	S	M										
CO5	S	S	S	M										

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry
		4	Alumni

LINEAR MODEL **9 Hours**

The phases of OR study – formation of an L.P model – graphical solution – simplex algorithm – artificial variables technique (Big M method, two phase method), duality in simplex.

TRANSPORTATION AND ASSIGNMENT MODELS **9 Hours**

Transportation model – Initial solution by North West corner method – least cost method – VAM. Optimality test – MODI method and stepping stone method.
Assignment model – formulation – balanced and unbalanced assignment problems.

PROJECT MANAGEMENT BY PERT & CPM **9 Hours**

Basic terminologies – Constructing a project network – Scheduling computations – PERT - CPM – Resource smoothening, Resource leveling, PERT cost.

REPLACEMENT AND SEQUENCING MODELS **9 Hours**

Replacement policies - Replacement of items that deteriorate with time (value of money not changing with time) – Replacement of items that deteriorate with time (Value of money changing with time) – Replacement of items that fail suddenly (individual and group replacement policies).
Sequencing models- n job on 2 machines – n jobs on 3 machines – n jobs on m machines, Traveling salesman problem.

INVENTORY AND QUEUING THEORY **9 Hours**

Variables in inventory problems, EOQ, deterministic inventory models, order quantity with price break, techniques in inventory management. Queuing system and its structure – Kendall's notation – Common queuing models - M/M/1: FCFS/∞/∞ - M/M/1: FCFS/n/∞ - M/M/C: FCFS/∞/∞ - M/M/1: FCFS/n/m

TOTAL: 45 HOURS

REFERENCE BOOKS:

1. Taha H.A., "Operation Research", Pearson Education
2. Hira and Gupta "Introduction to Operations Research", S.Chand and Co.2002
3. Hira and Gupta "Problems in Operations Research", S.Chand and Co.2008
4. Wagner, "Operations Research", Prentice Hall of India, 2000
5. S.Bhaskar, "Operations Research", Anuradha Agencies, Second Edition, 2004

OPEN ELECTIVES

U15BTOE01	BIOLOGY FOR ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn functions of living systems and constraints in life's boundaries
- To comprehend biological information in DNA and protein

COURSE OUTCOMES:

At the end of the course student will be able to:

CO1 **:** Express the organization of life.
CO2 **:** Interpret cell and its structure.
CO3 **:** Express the functions of organelles.
CO4 **:** Outline the principles of photosynthesis and respiration.
CO5 **:** Describe various aspects of Mendelian Genetics.
CO6 **:** Identify the key concepts in Molecular Biology

Pre-requisite: Nil

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	W													
CO2	W		S		M					M				
CO3			M		M	W							M	
CO4		W	M		M	M								
CO5		W	M		M					S				
CO6						S								

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
		3	Industry survey
3	End semester examination	4	Alumni survey

Course Content

INTRODUCTION **9 Hours**

Hypotheses, theories and science; Tree of life; Evolution; The chemistry of life: Acids, bases, buffers, carbohydrates, lipids, proteins and nucleic acids.

CELL **9 Hours**

Cell type; Structure and function; Tissue types: Muscle, neurons; Structure and function of DNA and protein; Mechanisms of DNA regulation; Stem cells and tissue engineering.

ORGANELLES **9 Hours**

Functions of organelles: Nucleus, ribosome, endoplasmic reticulum, mitochondrion, chloroplast, golgi complex; Molecular motors: Cytoskeleton.

MOLECULAR BIOLOGY AND GENETICS **9 Hours**

Concept central to life; Central dogma; Replication, transcription and translation; Mendel's laws and modern genetic terminology; Monohybrid cross and dihybrid cross; Patterns of inheritance: Dominant/Recessive; Sex-linked; Incomplete dominance and co-dominance.

FUNCTIONAL, COMPUTATIONAL BIOLOGY AND BIOETHICS **9 Hours**

Photosynthesis; Cellular respiration and energy; Membrane structure; Movement across membranes; Diffusion/Osmosis; Facilitated diffusion; Active transport; Endocytosis and exocytosis; Computational biology and bioinformatics; Ethics in biology and bioengineering.

Theory: 45 hours **Total hours: 45**

REFERENCES:

1 Campbell, Neil A., et al. *Biology: a global approach*. Pearson, 2015.
2 Raven, P., et al. *Biology. 9th ed.* McGraw Hill, 2010. Accession No. 45993.
3 Alters, Sandra. *Biology: understanding life*. Jones & Bartlett Learning, 2000.
4 Verma, P., et al. *Cell Biology, Genetics, Molecular Biology, Evolution & Ecology*.Chand, 2006.

OTHER REFERENCES:

1 http://nptel.ac.in/courses/102103012/
2 http://nptel.ac.in/courses/122103039/

U15BTOE02	BIOINFORMATICS FOR ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the types of data and its management
- To impart and understanding of the tools used for biological sequence data

COURSE OUTCOMES :

At the end of the course student will be able to:

CO1 : Explain the role of proteins, its structural aspects and protein folding diseases
CO2 : List the flow of information from DNA to protein
CO3 : Analyze biological data using tools such as dynamic programming and clustal
CO4 : Employ heuristic methods to search biological databases
CO5 : Construct phylogenetic trees and gene networks
CO6 : Mining biological information within high-throughput data

Pre-requisite: NIL

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S													
CO2			W	M										
CO3											W		S	
CO4					M								S	
CO5		S											S	
CO6	S				M						W		S	

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments	2	Faculty survey
3	End semester examination	3	Industry
		4	Alumni

Course Content

PROTEINS: SEQUENCE, STRUCTURE, REPRESENTATION **9 Hours**

Proteins and their role in organisms; Protein Data Bank (RCSB): .pdb files; detection with mass spec, prot crystallization, NMR ; protein folding and other diseases

9 Hours

GENOMICS AND RELATION TO PROTEOMICS

Central dogma, transcription, translation, regulation ; genomic diseases: mutations: germline vs somatic; Genbank and databases of importance

9 Hours

ALGORITHMS FOR SEQUENCE ALIGNMENT

Importance of sequence alignment; scoring matrices; global and local alignment; multiple sequence alignment; heuristic alignment

PHYLOGENTICS, GENE NETWORKS, PATHWAY ANALYSIS 9 Hours

Origin of species and homology; types of trees and algorithms of phylogenetic tree construction

HIGH-THROUGHPUT EXPERIMENTS AND DATA 9 Hours

Microarray experiments and their importance; data analysis; gene networks, Pathway analysis; RNA-Seq, Chip-Seq; Applications in disease detection.

Theory: 45 Hours **Total Hours : 45 Hours**

REFERENCES:

1 Attwood, Teresa K., and David J. Parry-Smith. *Introduction to bioinformatics*. Prentice Hall, 2003.

2 Gibas, Cynthia, and Per Jambeck. *Developing bioinformatics computer skills*. "O'Reilly Media, Inc.", 2001.

3 Ignacimuthu, S; Basic Bioinformatics, Narosa Publishing House, 22 Daryaganj, New Delhi (2005)

4 Durbin, Richard, et al. *Biological sequence analysis: probabilistic models of proteins and nucleic acids*. Cambridge university press, 1998.

5 Pevsner, Jonathan. *Bioinformatics and functional genomics*. John Wiley & Sons, 2015.

OTHER REFERENCES

https://www.cs.vu.nl/en/research/bioinformatics/links/index.aspx

U15BTOE03	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	0	0	3

Objectives:

- To provide knowledge on various aspects of intellectual property
- To learn procedures for patenting

Course Outcomes :

At the end of the course student will be able to:

CO1 : Understand different forms of Intellectual property.

CO2	**:**	Understand types of patents and patenting system in India.
CO3	**:**	Attain knowledge in patent filling process in India
CO4	**:**	Learn international patenting system
CO5	**:**	Distinguish various administrative and legal issues in Patenting process
CO6		Analysis impact of patent infringement

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSPO1**	**PSPO2**
CO1	S													
CO2	S	S	W		M								S	
CO3		M			S	W								S
CO4		M	W		S									
CO5		S			M	W						M		S
CO6		S			M	W						M	S	

Course Assessment methods:

Direct		**Indirect**	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

INTELLECTUAL PROPERTY RIGHTS **9 Hours**

Significance and types of IP- Patents, Trademarks, Copyright, Industrial Designs, Trade Mark, Trade secret and Geographical Indications; Objective and functions of GATT, WTO, WIPO and TRIPS; Farmers rights.

PATENT SYSTEM **9 Hours**

Criteria for patent; Patentable and non-patentable; Importance of patent; Concept of prior art, Type of prior art; Types of patents; Financial requirement – NDRC, New Delhi.

PATENT APPLICATION **9 Hours**

Indian Patent Act 1970- Recent Amendments; Role of a Country Patent office; Patent applications-Forms and guidelines, fee structure, time frames; Types of patent application; Patent specifications- provisional and complete specification.

INTERNATIONAL PATENT AND PATENT DATABASE 9 Hours

PCT- National and international phase, Advantage of PCT application, time frame, cost, procedure; Patent databases-India, USPTO, and EPO; Patent Stages of USPTO and EPO.

PATENT INFRINGEMENT 9 Hours

Definition of Patent infringement, patent litigation; Types of patent infringement; Administrative and legal case in India; Turmeric, Neem infringement case in India; Case study – Patent infringement

Theory: 45 Hours **Practical : Nil** **Total Hours : 45**

REFERENCES:

1 Deepa Goel and Ms Shomini Parashar , (2013), IPR, Biosafety and Bioethics, Pearson Educationpublisher

2 Shaleesha A. Stanley, (2007) 'Bioethics' Wisdom educational service, Chennai.

3 Erbisch, F H and Maredia, K M (1998) Intellectual property rights in agricultural biotechnology Universities Press (India) Ltd.

4 Singh. K, (2010) "Intellectual Property Rights in Biotechnology" BCLI, New Delhi

OTHER REFERENCES

1.http://www.ipindia.nic.in/ipr/patent/patents.htm

2. http://ipindia.nic.in/ipr/patent/journal_archieve/journal_2013/patent_journal_2013.htm

3. http://pfc.org.in/faq.htm

	BASIC PHYSIOLOGY FOR	L	T	P	C
U15BTOE04	ENGINEERING	3	0	0	3

Objective(s):

- To understand the fundamentals of cytology and biomolecules
- To learn the basic concepts of various types of physiological systems

Course Outcomes :

At the end of the course student will be able to:

CO 1 : Demonstrate the structure and functions of a cell and associated few organelles

CO 2 : Differentiate and explain the functions of various biomolecules

CO 3 : Summarize the various secretion processes, digestion and absorption phenomenon, and analyze the severity of diabetes mellitus

CO : Discuss the impact of blood, and functions of heart, and analyze the effect of

4 hypertension and myocardial infarction

CO 5 : Explain the gaseous exchange between the blood, lungs and tissues

CO 6 : Describe the structure of neuron, nephron and their associated functions

Pre-requisite: Nil

CO/PO Mapping **S-Strong, M-Medium, W-Weak**														
Cos	**Programme Outcomes(POs)**													
	PO1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSPO 1**	**PSPO2**
CO 1	S													
CO 2	S												W	W
CO 3	S	M				S						S		S
CO 4	S	M				S						S		S
CO 5	S	M				S						S		W
CO 6	S	M				S						S		W

Course Assessment methods:			
Direct		**Indirect**	
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

FUNDAMENTALS OF CYTOLOGY **9 Hours**

Cell: Definition, Overview of classification (pro- and eukaryotes), Functions; Cell membrane: Functions, Transport phenomenon (Simple diffusion and active transport); Nucleus: Overview of nucleic acids, Functions; Mitochondria and Golgi apparatus: Functions.

FUNDAMENTALS OF BIOMOLECULES **9 Hours**

Carbohydrates: Definition, Classification, Functions; Lipids: Definition, Classification, Functions; Amino acids: Definition, Classification, Functions; Proteins: Definition, Functions; Nucleic acids: Functions.

DIGESTIVE SYSTEM **9 Hours**

Salivary, gastric, biliary and pancreatic secretions: composition, functions; Liver: functions; Digestion and absorption: carbohydrates, lipids, proteins.
Case study: Diabetes mellitus

CIRCULATORY AND RESPIRATORY SYSTEM **9 Hours**

Blood: composition, function; Blood group – types, significance; Heart – structure, functions; Blood pressure: overview; Cardiac cycle: overview; Respiratory system: components, exchange of gases between lung and blood, exchange of gases between blood and tissues.
Case study: Biological units respond to mechanical stress (Clotting, Strength and stiffening, critical shear stress); Hypertension; myocardial infarction.

EXCRETORY AND NERVOUS SYSTEM **9 Hours**

Excretory system: structure of nephron, formation of urine, composition of urine; Nervous system: structure of neuron, types; Central nervous system: general organisation; Nerve transmission: action and resting potentials.

Theory: 45 Hours **Total Hours : 45**

REFERENCES:

1 C.C. Chatterjee. *Human Physiology Vol. I*, 11th Edition, CBS Publishers & Distributors Pvt. Ltd. India, ISBN-13: 978-8123928722, 2016.

2 C.C. Chatterjee. *Human Physiology Vol. II*, 11th Edition, CBS Publishers & Distributors Pvt. Ltd. India, ISBN-13: 978-8123928739, 2016.

3 Hall, John E. *Guyton and Hall textbook of medical physiology*. Elsevier Health Sciences, 13th Edition, ISBN: 978-1-4557-7016-8, 2015.

4 U. Satyanarayana. *Biochemistry (with clinical concepts and case studies*, 4th Edition, Elsevier Inc. USA, ISBN: 978-81-312-3601-7" 2013.

5 Nelson, David L., and Michael M. Cox. *Lehninger Principles of Biochemistry*.5th revised Edition, W. H. Freeman Publishers, ISBN: 1429277718, 9781429277716, 2009.

6 Johnson, Arthur T. *Biology for Engineers*. CRC Press, ISBN: 978-1-4200-7763-6, 2011.

OTHER REFERENCES:

1 http://nptel.ac.in/courses/102105034/

2 http://home.earthlink.net/~dayvdanls/IHP1.html

3 https://www.youtube.com/watch?v=1h2VW8USCAA

4 https://www.youtube.com/watch?v=oHMmtqKgs50

5 https://www.youtube.com/watch?v=GjfD55C9v38

U15BTOE05	ENZYMES FOR TEXTILE PROCESSING	L	T	P	C
		3	0	0	3

Objectives:

- To understand the basics of enzymes, classification and mechanism
- To study the different processing techniques in textile
- To study the applications of enzymes in textile processing

Course Outcomes (COs):

At the end of the course student will be able to:

CO1 Explain the basics of enzymes, mechanism and salient features

CO2 Discuss the role of environmental biotechnology in textile industry

CO3 Illustrate the different enzymes used in textile processing

CO4 Discuss the enzymatic treatment in textile processing

CO5 Evaluate the enzymatic treated fabrics

CO6 Explain the applications of bioprocess in textile processing

Pre-requisite: NIL

CO/PO Mapping

S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1		S				M								
CO2	S			S										S
CO3		S			M									S
CO4		S		M										
CO5	S				M									
CO6		S	M											

Course Assessment methods:

	Direct		Indirect
1	Internal Tests	**1**	Course end survey
2	Assignments	**2**	Faculty survey
3	End semester examination	**3**	Industry survey
		4	Alumni survey

Course Content

ENZYMES IN TEXTILE PROCESSING **9 Hours**

Introduction to enzymes: classification of enzymes; mechanism of enzymes; Factors affecting efficiency of enzyme treatment, Salient features of enzyme applications in textile processing; Advantages and properties of enzymes used in textile processing

ENZYMES IN ENVIRONMENTAL APPLICATIONS **9 Hours**

Pollution and its control in textile processing industries; Waste water treatment systems: Anaerobic & Aerobic systems; Bio-degradation: Microorganism in pollution control; Bio mass production; waste as renewable sources of energy: Production of biogas; Hydrogen fuel.

ENZYMES USED IN TEXTILE INDUSTRY **15 Hours**

Enzymes for desizing, scouring & bleaching Enzyme activity – initiation, propagation and termination reactions – reaction conditions – properties of substrates and results of enzyme treatment. Enzyme activity of amyloglucosidase, pectinase, glucose oxiclase, peroxidases and other enzymes used for bleaching decolourisation of textiles using laccases; Bio-Polishing enzymes such as cellulases; Bio-washing enzymes using cellulase proteases for scouring of animal fibres, degumming of silk and modification of wool properties.

EVALUATION OF ENZYME TREATED FABRICS **6 Hours**

Weight loss, Whiteness index, Absorbency, Tensile strength, Handle of fabric and Abrasion resistance. SEM analysis and other structure related studies.

BIO – PROCESSING IN TEXTILES **6 Hours**

Bio-bleaching, combined bio - processing, bio washing, bio polishing, Denim fading, anti odour and anti microbial finishes, bio-finishing and other applications.

Total Hours : 45

Theory: 45 Hours **Tutorial /Case study: 0** **Total Hours:45**

REFERENCES:

1. Trevor Palmer, Enzymes (2007); Biochemistry, Biotechnology and Clinical Chemistry, 2nd Edition, Horwood Publishing Limited, United Kingdom.
2. Georg M. Guebitz, Artur Cavaco-paulo, Ryszard Kozlowski, (2006); Biotechnology in Textile processing, CRC Press, Inc.
3. Asfert L.O and Videback.T (1990); Intl Textile Bulletin – Dyeing / Printing / Finishing.
4. Cavaco - Paulo, Gubitz, Textile Processing With Enzymes, Wood Head Publishing Ltd, UK, 2003.
5. http://textilelearner.blogspot.in/2013/03/enzyme-and-its-applications-in-textile.html.

ONE CREDIT INDUSTRY ORIENTED COURSES

U15BTIN001	DAIRY TECHNOLOGY	L	T	P	C
		2	0	0	1

Objectives:

- To understand and learn about various aspects of milk.
- To learn in detail about milk processing techniques and products.

Course Outcomes :

At the end of the course student will be able to:

CO1: Understand the basics of milk.
CO2: Learn about various processing techniques of milk.
CO3: Understand various equipments in milk processing
CO4: Learn grading and assessment of milk quality
CO5: Learn GMP practices in dairy industry
CO6: Understand process of production the different dairy products.

Prerequisite courses: Nil

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S												S	W
CO2	S		M										S	W
CO3	M												S	M
CO4	S												S	W
CO5													S	W
CO6	S				M								S	

Course Content

Milk basics **3 Hours**

Milk: Composition – factors affecting milk composition – nutritive value of milk – physicochemical properties of milk & milk constituents – microbiology of milk.

Milk Processing **3 Hours**

Milk Processing – collection storage – receptor (platform tests) – pasteurization – sterilization – homozenization – centrifugation – membrane separation – cooling – packing .

Equipments used in dairy industry **3 Hours**

Coolers, pasteurizers, sterilizers – homogenizers – centrifuges – membrane separation unit – packaging equipments, FFS machine, Vacuum packaging, dryers.

Quality Control in Milk **3 Hours**

Judging and grading of milk – plat form tests (smell, appearance, sediment, temperature, acidity, lactometer) sampling – testing – Clean-in-place (CIP) – (HACCP) Hazard Analysis and Critical Control Point – Good Manufacturing Practices (GMP), National & International standards of milk & Milk Products.

Milk Products **3 Hours**

Milk Products Butter – Cheese – Ice Cream, Ghee etc. Waste Management – Whey, Whey Proteins – Solids –New Product Development. Visit to Sakthi dairy- Testing milk and products.

Total Hours :15

Theory: 15 Hr **Total Hours :15**

References:

1. Sukumar De, Outlines of dairy technology,1st Edition, Oxford University Press, 1980.

U15BTIN002	MUSHROOM TECHNOLOGY	L	T	P	C
		2	0	0	1

Objectives:

- To understand and learn about various edible mushrooms that are commonly cultivated and consumed.
- To learn in detail on cultivations steps and practices for edible mushrooms and their beneficial effects on human health.

Course Outcomes :

At the end of the course student will be able to:

CO1: Understand biology of edible mushrooms
CO2: Cultivation techniques of button and oyster, mushrooms
CO3: Cultivation techniques of milky and paddy straw mushrooms.
CO4: Understand the problems in mushroom cultivation
CO5: Explain the nutritive value of mushrooms
CO6: Understand the therapeutic effects of mushrooms

Prerequisite courses: Nil

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S												S	
CO2			M										S	
CO3	M												S	
CO4	M												S	
CO5			S										S	
CO6							M						S	

Course Content

Biology of Mushrooms **2 Hours**

Classification fungi, life cycle of fungi, parts of a typical mushroom, properties of edible mushrooms, differentiating edible mushroom from poisonous mushrooms. Different types of Button, Oyster, Milky and Paddy straw mushrooms - General morphology.

Mushroom Cultivation techniques **8 Hours**

Cultivation systems- Button mushroom, Oyster mushroom, Milky mushroom and Paddy straw mushroom. Problems and remedial measure in edible mushroom cultivation.

Nutritional statistics and beneficial effects of edible mushrooms **5 Hours**

Carbohydrate, protein, essential aminoacids, fats, vitamins, polyphenols and antioxidants calorific values, of edible mushroom fruiting bodies. Antiviral, antibacterial effect, antifungal effect, anti-tumour effect, therapeutic properties of edible mushrooms.

Total Hours :15

Theory: 15 Hr **Total Hours :15**

References

1 Mushroom Production and Processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).

2 Mushroom Cultivation, Tripathi, D.P. (2005) Oxford& IBH Publishing Co. PVT.LTD, New Delhi.

U15BTIN003	PILOT-PLANT AND INDUSTRIAL FERMENTORS	L	T	P	C
		2	0	0	1

Objective(s):

- To learn about ancillaries of pilot-plant and industrial fomenters
- To understand the need of pilot-plant fomenters
- To learn the applications of pilot-plant fomenters

Course Outcomes :

At the end of the course student will be able to:

CO1 : Understand the basic components of pilot-plant fomenters
CO2 : Outline the importance of pilot-plant fermenter in biotech. industries
CO3 : Learn about components of industrial fermenter
CO4 : Understand parameter control in fermenters
CO5 : Identify fermenter accessories and their functions
CO6 : Understand product recovery of a fermentation products

Pre-requisite: Nil

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S												S	
CO2		S											S	
CO3			M										S	
CO4		S											S	
CO5			S										S	
CO6													S	

Course Content

PILOT-PLANT FERMENTER:

Advantages and types of pilot-plant fermenters, Design and operation of pilot-plant fermenters; Material of construction, aeration and agitation, temperature control, automatic antifoam control, automatic pH control, and facilities for air sterilization; Scale-up parameters in fermenters; Development of products

using pilot-plant fermenter; Control of a fermenter by digital controllers interfaced with computers for continuous acquisition of online data and for process control;

INDUSTRIAL FERMENTER:

Temperature and pH control, aeration and agitation, Fermenter accessories, Product recovery

Total Hours :15

Theory: 15 Hr **Total Hours : 15**

REFERENCES

1 James M. Lee, *Biochemical Engineering*, http://jmlee.org/documents/ebiochesample.pdf
2 Pauline M. Duran , *Bioprocess Engineering Principles*, Elsevier 2009
3 Shuler, M.L. and F. Kargi, *Bioprocess Engineering Basic Concepts* 2Ed, PHI Learning Pvt Ltd., 2008

U15BTIN004	BIOETHANOL TECHNOLOGY	L	T	P	C
		2	0	0	1

Objectives:

- To learn about the feed-stocks, fermentation and purification of bioethanol

Course Outcomes :

At the end of the course student will be able to:

CO1 : Describe the economic, social and environmental aspects of bioethanol
CO2 : Illustrate the feedstocks for bioethanol
CO3 : Demonstrate the fermentation routes for bioethanol production
CO4 : Outline the purification steps involved in bioethanol fermentation
CO5 : Illustrate the important uses of coproducts of bioethanol production
CO6 : Understand the future prospects of bioethanol

Pre-requisite: Nil

CO/PO Mapping
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1							S							S

CO2	M													S
CO3	S			S										S
CO4	S													
CO5												S		S
CO6														

Course Content

BIOETHANOL **5 hrs**

Introduction: Economic aspects, energy balance, main drivers; Global production: statistics, international and national directives, current and emerging status. First generation (sugars and starch), second generation (lignocelluloses), third generation (algae), feedstocks with future potential, feedstock processing, alternative routes to bioethanol

FERMENTATION AND PURIFICATION **5 hrs**

Ethanologenic microorganisms, theoretical and applied aspects, ethanol fermentation from sucrose, starch hydrolysate, lignocelluloses hydrolysate and algae hydrolysate. Distillation: Theoretical and applied aspects; Adsorption: Theoretical and applied aspects; Quality control: Quality parameters (process and product), alcohol specifications.

ENVIRONMENTAL ASPECTS AND FUTURE PROSPECTS **5 hrs**

Environmental aspects: Sustainability and climate change, energy and water conservation, co-products: generation and utilization, effluent treatment and control; Future prospects: Global trends and issues, future challenges.

Total Hours : 15

Theory: 0 Hrs **Total Hours : 15 Hrs**

REFERENCES:

1 Walker, G.M., *Bioethanol: Science and technology and fuel alcohol*, Graeme M. alker & Ventus Publishing ApS, 2010

OTHER REFERENCES:

1 www.ethanol.net